BCSSA/BCPSEA/WCB **AUGUST 2004**

EXPERT PANEL

ON

REDUCING THE

NUMBER OF SLIPS/FALLS

IN

SCHOOL DISTRICT FACILITIES

ACKNOWLEDGEMENTS

The ***Expert Panel*** working on the project entitled ***Reducing the Number of Slips and Falls in School District Facilities Where Flooring/Flooring Treatments May Be a Factor*** would like to thank the British Columbia School Safety Association (BCSSA), the British Columbia Public School Employer's Association (BCPSEA) and the Workers' Compensation Board of British Columbia (WCB of BC) for their sponsorship.

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Harvey Linton, Industry Services Manager, General Industry, Prevention Division, the Manager who arranged WCB support in respect to the project.

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Jim Turnball, Vice-President, ZEP, Edmonton, Alberta

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EXECUTIVE SUMMARY

In April 2004, an Expert Panel was selected and charged with investigating the cause of slip/fall incidents in School District facilities. Over the following eight week period, the Expert Panel focused its attention on slips/falls that occur indoors and on the same level.

The Expert Panel began its work by attempting to collect data from the WCB and from contributing School Districts. The Panel discovered that data is available, however, it has not been acquired in a manner that would allow outside reviewers to focus on the root cause of incidents and the contributing factors. The data did, however, confirm that slips and falls did occur and in the same general frequency as appears in the literature (that 15-20% of total claims are derived from slips/falls). On that basis, it was evident that slips and falls cost School Districts a considerable sum of money (in staff replacement costs, in time-loss absences, in medical costs, in rehabilitation costs and in pensions). The panel concluded that reviewing slip/fall incidents from a prevention perspective was warranted.

The Panel canvassed Occupational Health and Safety Agencies across Canada. None of the Agencies had studied the slip/fall issue from this perspective. The Agencies were interested but were unable to provide information.

The Expert Panel quickly determined that the slip/fall problem would not be easy to resolve. Many factors contribute to slips and falls. Only a few factors are actually under the immediate control of a building owner/operator.

The Expert Panel determined that selection of flooring material was a significant factor in slip/fall incidents and was one that would be within the control of the building owner/operator. The Panel found that looks alone should not dictate the choice of flooring material; choice required careful consideration of durability, use pattern, environmental factors and maintenance capabilities. A principal consideration needed to be floor slipperiness (the *coefficient of friction)*.

The Expert Panel determined that the slip/fall problem did not end with the selection of suitable flooring material. To maintain its non-slip properties, flooring material had to be protected from wear. The choice of floor treatment (coating) could significantly alter the ability of a flooring material to maintain a suitable coefficient of friction. A non-slippery floor could be rendered slippery if the floor coating was allowed to wear away. As well, a non-slippery floor could be rendered slippery by the application of an improper floor finish.

The Expert Panel determined that floor slipperiness was also a property of on-going floor maintenance. Clean floors are less slippery than dirty floors. Surface contaminants on a floor not only destroy the floor finish but also act between the sole of a shoe and the floor

surface to cause a loss of friction (and resultant slips/falls).

The Expert Panel discovered that floor slipperiness (coefficient of friction) could be measured. Some 70 types of slip-test meter (tribometers) are available. However, the Panel discovered that slip-test meters used in Laboratories to measure floor slipperiness although precise cannot be used to evaluate floor slipperiness in the field. Field slip-test (coefficient of friction) data collected using portable slip-test meters does not correlate with Laboratory test data. The presence of contaminants and liquids affect readings. As well, data from tests performed on dry flooring material cannot be used to make judgments about wet flooring material. All these complications raised significant concern in the mind of the Panel about the possibility of achieving a reliable and comparable floor slipperiness measurement.

Notwithstanding these difficulties, the Expert Panel reached a conclusion that in-field testing of floor slipperiness needs to be conducted. The Panel felt that testing inconsistencies between portable slip-test meters could be reduced (perhaps, overcome) if instrumentation was standardized, if common use practices were devised, if field evaluators were trained in the same testing procedure and, if tests were conducted appropriately under those procedures. The Panel felt that, if School Districts commenced such a program of field testing and, if testing results were recorded over time, a *performance database* could be established. School Districts would then be able to pool performance database results and use the information to select better flooring materials, better floor treatment products and better floor maintenance practices thereby lessening the risk of slip/fall incidents/injuries.

The Expert Panel prepared a set of recommendations designed to assist in the reduction of slip/fall incidents. The Expert Panel offers these recommendations to School District decision-makers with the expectation that Districts will find one or more of the suggestions both useful and preventative. The **Expert Panel suggests:**

1) that the Recommendations Section of the report be distributed to School Districts and School District personnel (maintenance and design). The Expert Panel suggests that the study report Recommendations also be tabled for discussion in upcoming School District meetings (or, forums) so that the material elicits discussion.
2) that a follow-up study be conducted in two years time to determine which recommendations have been adopted in the Districts and which recommendations have realized their preventative potential. The follow-up study would also examine the database records collected in the Districts for correctness and completeness. At that time, the database material could be examined for trends.
3) that a another set of studies be considered for joint sponsorship; ones broader in scope designed to look at slip/fall incidents in outdoor locations and slip/fall incidents between levels (not just on the same level). The Panel is convinced of the worth of this slip/fall study but "*falls on the same elevation*" and "*falls indoors*" are only part of the overall slip/fall issue.

PANEL MISSION STATEMENT

Mission Statement

At its first meeting on April 6, 2004, the Panel defined its Mission Statement to be:

An Expert Panel will review WCB statistics on School District WCB claims across B.C. (and, School District information regarding those incidents) focusing upon slips and falls on a single elevation in buildings. From this information, the Expert Panel will attempt to determine if the flooring material and/or the floor treatments contributed significantly to the incident. At the end of its study, the Expert Panel will present recommendations regarding the selection of flooring material and floor treatments in the hope of preventing (or, at least reducing) further incidents. The Expert Panel will make recommendations about the feasibility of in-field measurements of floor surface slipperiness (measuring coefficient of friction in work circumstances).

PROJECT STRATEGY

BCPSEA allotted the Expert Panel eight weeks in which to complete its work.

In such a truncated timeframe, the scope of the project had to be narrowed considerably to only include: (a) slips/falls indoors; (b) slips/falls on the same elevation; and, (c) only slip/fall data that could be provided expeditiously by contributing School Districts and the WCB.

Panel Members were selected by BCPSEA. BCPSEA polled School Districts across British Columbia for participants. Although several School Districts indicated an interest, only four School Districts were able to provide expert member attendees in the timeframe allotted to the Panel to complete its work.

The four School Districts who were able to participate:

- the Greater Victoria School District,
- School District #8 - Kootenay Lake
- School District #60 - Peace River North and
- the Vancouver School Board

sent representatives to a series of meetings (in Vancouver) and to a meeting in Penticton. Members participated in several teleconferences.

The School District Panel attendees agreed to seek input from colleagues in neighboring School Districts and agreed to contact local suppliers of flooring and floor treatment products in their Districts for information. The information collected by the Panel members was presented at subsequent Panel meetings.

Industry experts were identified by the Panel members and several experts were invited to present on their topic of expertise at Panel meetings. Several Industry experts agreed to participate. Some attended Panel meetings; others offered advice by telephone, fax and e-mail.

At the end of the allotted eight week interval, the Panel members agreed that the information tabled would be scrutinized and a report would be written. The report would attempt to address the issues defined in the project mission statement.

PROJECT SUMMARY

Under the auspices of the BCPSEA and with the concurrence of the BCSSA and the WCB, an Expert Panel was constituted in April 2004 to look at slip/falls incidents indoors and on the same elevation in School District premises in British Columbia.

The Expert Panel met and corresponded over a period of eight weeks. The Project Mission Statement required the Expert Panel to:

- examine WCB data on slips & falls on the same elevation in School District buildings;
- examine and evaluate data from participating School Districts on slips and falls on the same elevation in School District buildings;
- from the WCB and School District information, attempt to determine if the flooring or if the floor treatment material contributed significantly to the slip and fall incident.
- from that determination, make recommendations about the choice of flooring and/or floor treatment materials; and
- make observations and recommendations about the in-field measurement of floor slipperiness.

The Panel approached the WCB for data. The Panel discovered that the WCB could only supply data on slips and falls that resulted in time loss claims; non-time loss claims (medical aid only claims) were not coded and details were not captured by the WCB. As a result, a significant amount of incidence data was not available for study. The Panel also discovered that the data collected for claims adjudication purposes by the WCB did not include information crucial to the analysis of slip/fall incidents from an accident prevention perspective (information such as: type of flooring, type of floor treatment applied, floor maintenance techniques in use, condition of the flooring, the type of footwear being worn, the activity underway at the time of the incident, etc). Notwithstanding, the WCB-generated data from slip/fall time loss incidents was useful in estimating incidence frequency and for estimating incidence severity. The Panel was able to use information collected by the WCB to validate information found in literature references - that about 15-20% of slips and falls fit into the category of indoors and on the same level. The Panel became convinced that, if suitable control techniques were identified and applied, a significant reduction in injuries (and attendant costs) would ensue.

The Panel approached various School Districts for data. The Panel discovered that Schools Districts did not collect slip/fall information in a common format. Due to the lack of standardization, the Panel found that it was difficult to correlate slip/fall incidence data between School Districts. The Panel also discovered that the data collected in the Districts did not include information crucial to the analysis of slip/fall

incidents (information such as: type of flooring material, condition of the flooring (damaged or broken up), type of floor treatment in regular use, type of floor treatment actually applied (at the last treatment), date since last floor treatment application, presence of contaminants on the floor (boulder dust, oil, water), coefficient of friction measurements (either as laid at installation or at the time of the incident), type of footwear being worn, condition of the sole portion of that footwear, what activity was underway at the time of the incident, etc). Without such detail, it was impossible for the Panel to isolate the root cause of the incidents or the contributing factors. The School District data did confirm that slip/fall incidents were common and in the expected range described in literature sources (slips/falls representing 15-20% of total claims). The School District information also confirmed that the introduction of suitable control techniques would reduce the potential for slip/fall incidents with the resultant reduction in overall costs.

From the Panel's literature review and, from the information provided to the Panel by expert guests, the Panel was able to affirm the need for structured floor maintenance programs. The Panel came to the realization that floor cleanliness as a means of slip/fall control cannot be over emphasized. The Panel will recommend that School Districts place increased emphasis on regular cleaning of floors and premises.

The Panel came to believe that School Districts need to take in-field measurements of the coefficient of friction of floor surfaces. School Districts need this information in order to diagnose acceptable floor treatment schedules and to confirm correct treatment application techniques. The Panel also concluded that School Districts need to pool their resources and exchange information collected regarding coefficient of friction of floor surfaces following the use of various floor cleaning products and after the use of floor resurfacing products, especially after the introduction of a new product.

From the Panel literature review and, from information provided to the Panel by expert guest speakers, the Panel was able to affirm the need for careful selection of flooring materials prior to commencing construction and/or installation. However, Panel members were unable to identify the process by which School Districts choose flooring materials (during the design of new School District facilities) and the Panel was unable to confirm how floor materials are chosen for installation in refurbishing situations. It was not clear to the Panel if coefficient of friction values are being used as a tool (or requirement) by engineers and architects advising School Districts nor was it clear to the Panel what coefficient of friction value is being specified as acceptable.

Panel members from the Vancouver School Board (VSB) did confirm that they have intervened in the choice of certain products in evident risk situations (e.g., where ceramic floor tile was suggested as a flooring material in a situation where moisture was a common contaminant) A VSB Panel member intervened to prevent the installation as such tile was known to present a slipping hazard when tiles are wet.

The Panel found that it was unable to make meaningful recommendations about the use of a particular flooring material. Amongst the School Districts, there are too many flooring materials in use and there are too many regional environmental variables to consider. The Panel noted that, even if they were to recommend a certain flooring material, the original properties of flooring material may be significantly altered by the local choice of a floor treatment material (coating) after installation. The Panel also noted that the original attributes of the flooring material could be altered by the way the floor is prepared for treatment between floor coatings and by the use pattern of the flooring after installation.

The Panel did accept the need for School Districts to select flooring with a suitable coefficient of friction - one appropriate to the environmental conditions of use (e.g., not to put a flooring material in place that would become slippery by the mere nature of its surroundings). The Panel considered that flooring manufacturers are a prime source of coefficient of friction information and are able to make reasonable recommendations regarding the correct selection and care of flooring materials. As well, the Panel believes that floor treatment manufacturers are a reliable source of recommendations for the care and treatment of the flooring material once it is in place. In discussion with the Panel, Mr. Nicholas (from Janitors' Warehouse) advised that floor coating manufacturers formulate their coating products so as to yield a coefficient of friction result in excess of 0.5 (on correct application), as tested in a Testing Laboratory by the James Machine.

The Panel recognizes that School Districts expend considerable resources in the selection of flooring products and floor treatment materials. School District personnel are being constantly challenged by suppliers with a myriad of products to sell. All the salespeople claim to have a solution to the slip/fall problem. The Panel believes, however, that School Districts should learn from each other. If there were a common, objective and reliable method of collecting data on the performance of floor materials and floor coatings and, if the data could be readily exchanged between Districts, the on-going search for superior performing products could be reduced. Effort expended in the search and costs associated with the search could be reduced. Information on floor substrate problems and floor coating failures would be available to other Districts (reducing the likelihood of purchasing a "*problem*" material). Manufacturers and suppliers would become challenged to supply products whose performance would be assured (as it was being monitored and reported). The Panel has provided a set of recommendations for consideration related to the creation of just such an information-exchange network/database.

The Panel considered the issues around the in-field measurement of coefficient of friction. The Panel appreciates the physical and technical difficulties in obtaining reliable in-field coefficient of friction results especially where there are contaminants present. The Panel believes, however, that these difficulties can be overcome with a suitable set of procedures, with operator training and with on-going quality control during the testing process.

The Panel appreciates that the coefficient of friction results collected in-field by portable measurement devices cannot be correlated to the Industry-standard laboratory testing apparatus (the James Machine). The Panel believes, however, that the same make and model of field testing apparatus - used by trained and experienced personnel following standard operating practices - would collect data that can be used for general cross-District performance comparison purposes. The issue would not be to have a single irrefutable number, the issue would be to alert District to performance trends and, by so doing, allow them to act proactively.

The Panel acknowledges the relatively high initial purchase cost of field slip-testing devices. However, the Panel believes that the collection of floor slipperiness data over time and in similar use circumstances will improve decision-making around the establishment of floor maintenance intervals, will help assign realistic and defensible re-treatment schedules and will assist in identifying the better commercial products that are available. The savings realized by such objective results will, over time, offset the initial purchase cost of a slip-test meter.

The Panel believes that the current subjective estimation of floor slipperiness in an actual slip/fall situation does not provide sufficiently accurate information to an incident investigator. An objective method needs to be introduced that allows both the collection of and, the exchange of, slipperiness data following an slip/fall incident. To that end, the Panel recommends that School Districts purchase and use a slip-test meter (tribometer). School Districts should purchase the same make and model of slip-test meter and should follow a standard set of testing procedures. School Districts are also encouraged to take regular and repeat readings of floor surfaces throughout the year and to log those results. A database built in this manner in a District can not only be used to evaluate floor material performance, floor maintenance practices and floor treatment products in actual use but can also be used to demonstrate due diligence should a legal action result after a fall.

The Panel believes that slip-test measurements can become a valuable prevention tool. Being able to intervene before the coefficient of friction of a floor falls below acceptable slipperiness criteria (below 0.5) would do much to prevent slip/fall situations from developing.

The Panel recognizes that simply acting on one component of the slip/fall problem is not enough; such a narrow focus will not realize the required result.

Education of people is crucial. People need to be alerted to the slip/fall risk and, importantly, to a change in slip/fall risk (i.e., that a liquid may be present that creates a slippery situation). Signs warning of the slip/fall hazard act significantly to increase pedestrian awareness - the literature suggests that an alert individual will alter their stride to offset the slip/fall risk. Floor maintenance personnel need to place signs alerting pedestrians to the increase in risk and, importantly, need to remove those signs as soon as the risk is eliminated (or, the effect of signage will be lost).

Panel members recalled a recent BCPSEA-led awareness campaign in which literature on slips and falls was made available for distribution to workers in the various Districts. A Panel member from the Kootenays indicates that this literature was sent home as an inclusion with pay envelopes and, in the period immediately after (and, for some months thereafter), the frequency of slip/fall incidents in the District fell to zero. The Panel recommends another education and awareness-enhancing campaign be undertaken across the Districts.

The Panel also recognizes that there is a need to address the footwear issue. Some types of shoe may not be suitable in a work situation. In conjunction with the education/awareness campaign, the Panel recommends that School Districts offer a guide to the selection of suitable footwear. The guide would include recommendations about selecting the style of footwear, the type of sole material, the necessity to choose a shoe appropriate to the activity and the need to keep the footwear in a good state of repair.

Statistics indicate that far more women slip and fall than men (even adjusting for the increased number of women employed in the teaching profession). Speculation around the increase in slip/fall incidents between men and women includes: the type of shoe worn (women generally wear narrower shoes than the men reducing the sole surface available for gripping the floor); women tend to wear shoes with more of a heel (perhaps adding to an imbalance condition in some carrying situations); and women tend to have more shoes than men (men are more familiar with the footing they receive from their shoes as they wear the same pair of shoes more frequently). School Districts may already have a safety footwear reimbursement policy in place so non-slip criteria might be imposed as part of the safety footwear purchase practices in place. For non-safety footwear, School Districts may wish to consider addressing shoe selection as part of their "*acceptable dress*" criterion.

INFORMATION FROM THE PROJECT

Global Overview of Slips & Falls:

In the literature, Sacher (1993) defines a slip as "*…as a sudden loss of footing, resulting from an unforeseen, unexpected and out-of-control slide of the foot. Normally, it is the end product of insufficient friction…".*

Slips may result in falls and falls often lead to injuries. However, it is not uncommon for an injury to arise out of a slip even though an actual fall may not occur. When attempting to recover from a slip, an individual may twist their back as they attempt to regain their balance or, to prevent a fall, an individual may grab at a railing or part of a structure perhaps pulling a muscle in their shoulder as they arrest their fall.

For example:

- A Year 2001 WCB review of 200 Employer's Form 7 reports to the WCB from Surrey School District (unpublished WCB data) includes this Teacher statement:
  Walking down the hall towards classroom, slipped on a wet surface and fell. Tried to prevent fall, but was unable to do so. Twisted back, fell on R side, and hit head on wall.
- In the same set of WCB-scrutinized Employer' Form 7 reports (unpublished WCB data), a Surrey School District Custodian states:
  I was scrubbing my linoleum floor which I had flooded with a soapy water solution. I walked on it and slipped. I fell backwards and landed on my hand which I put behind my back. Damaged ligaments & tendons R thumb.
- A Year 2001/02 Vancouver School District account of a Teacher's Aide incident on another Employer's Form 7 (unpublished VSB data) report to the WCB states:
  She slipped outside of lunchroom door & caught herself with L arm, twisted her body & throwing out her L shoulder.

English (1995) points out that, in the United States,

> "*Fall statistics published annually by the National Safety Council show that the portion of the population at greatest risk of falling injuries is post menopausal women, with the curve rising steeply after age 65. This suggests that people become more vulnerable to falls (1) as their reflexes slow and their muscle tone declines…*

Although the aging population may be at greater risk, no one is immune from harm if they slip and fall.

Slips and falls injuries are a serious world-wide issue. In Europe (Risk prevention, 2001), "*...inadvertent slipping is responsible for 12% of working accidents in France and 5% of serious accidents for people more than 60 years of age in Europe."* In New Zealand (Slip resistance of pedestrian surfaces, 1993), "*...in each of the calendar years from 1982 through 1984, the Accident Compensation Corporation of New Zealand received approximately 7500 claims because of injuries resulting from falls caused by slipping. 60% of these occurred during non-work activities and 40% at work..."* In Britain (Preventing slip and trip incidents, 2003), "*The financial cost of slip and trip incidents are considerable. Based on 1999/2000 figures it is estimated that they cost employers L368 million and society as much as L763 million."*

Slips and falls injuries are a serious occupational issue. "*Some 15 percent of accidental workplace deaths are caused by slips, trips and falls, which are second only to traffic crash fatalities as a leading cause of fatal workplace injuries"* (ANSI Standard addresses fatal injuries, 2002). And, Keyserling (2000) notes, "*Occupational fatalities due to falls are approximately 600 per year...Disabling (temporary and permanent) occupational injuries due to falls are approximately 250-300 K per year...Falls on the same level (approximately 60% of compensable fall cases)..."* In Britain, "*In one accident a school meals employee slipped on a custard spilt on the wooden parquet flooring of a school dining-room just as the clearing away and cleaning operations were beginning. She broke her leg and died later from a blood clot."* (Preventing slip and trip incidents, HSE, 2003).

Slips and falls injuries are a serious public issue. In Australia (Aussies Need 'Roadworthy' Shoes, 2000), "*Australia's four biggest supermarket chains are estimated to have paid more than $40 million in damages to customers in 1998. Many claims were from people who had slipped after spillage of supermarket product on the shop floor...A 1990 study of public liability incidents revealed that 76% of actions were due to slips and falls."* In Britain (Health Services Sheet No. 2, 1996), "*...in healthcare...trips account for 62% of major injuries to members of the public...the total estimated cost of civil claims for slips and trip injuries to employees and the public in or on NHS premises in England...over the last four years exceeds L25 million..."*

Closer to home, Gallagher and Scott (1995) studied falls in public places in and about Victoria, B.C. The subject population was seniors and persons with disabilities. Although these are not the primary focus of day-to-day activity on School District properties, they are still a group of people who do visit School District premises with some regularity. Gallagher and Scott report (in Table 3, page 26) that the common indoor slip/fall locations for seniors are:

Location:	% of Occurrences
Floors	43%
Stairs	28%
Lobbies/Hall	16%
Obstacles	8%
Escalators	5%

Information of a similar nature provided by the WCB for falls on the same level in Public School Districts for the period 1998-2002 (unpublished WCB data) indicated a similar distribution pattern for workers:

Location	% of Total Falls
Floor of building	36.9
Ground	14.2
Floors, walkways	12.7
Parking lots	8.0
Sidewalks, paths	3.4
Streets, roads	1.6

Gallagher and Scott (1995) also indicate that substrate surface condition made a significant contribution to the number of slips and falls (extracted from Table 4, page 28):

Surface Condition	Reported Incidents	Actual Slips/Falls	Near Slips/Falls
Uneven	260	220	40
Wet	120	100	20
Broken	65	45	20
Poorly Lit	35	25	10
Littered	25	20	5
Snow/Ice	25	20	5

In the Gallagher and Scott report, uneven floors - where the height varied from one section to the next - was the most significant contributor to slips/falls affecting seniors. Often, this appeared to be an issue of lack of perception of the change of elevation. Wet floors were the next biggest contributor to slips/falls. Speculation would suggest a failure to recognize the presence of the wet patch and, accordingly, the failure to adjust gait to compensate. Flooring that was damaged (e.g., a broken-up surface) was the third significant contributor. When people stepped onto the damaged portion of the floor, a portion gave way underneath their foot causing instability and leading to loss of footing and fall. The report indicated a correlation between surface condition and the location where seniors fell most often (the common indoor slip/fall locations) - most often the flooring in the location of the slip/fall was uneven, damaged or wet.

Information extracted from 200 WCB Form 7 reports for the Year 2001 in the Surrey School District (unpublished WCB data) indicated, in support of Gallagher & Scott's conclusions:

Teacher: *Tripped from lino to carpet. Jarred my back into pain and spasm. Pain both legs*.

TA Special Needs: *Tripped on edge of carpet in hallway. Twisted L shoulder & back*.

Clerical: *Slipped in pool of wax stripper. No warning signs posted. Pulled tendons R wrist, R foot, stiff shoulder*.

Slips and falls information from the Vancouver School Board for the Years 2001 to 2003 (unpublished VSB data) indicates that incidents occurred in the following locations in District schools. Of particular interest in these tables is the number of falls occurring on the "*same elevation*" in comparison to the "*total falls*" figure and the fact that most falls on the same elevation occur in halls, entranceways and classrooms. The Panel expectation was that gymnasiums would be a significant source of slip/falls due to the nature of the activities that are underway in a gymnasium. They were not. A mitigating factor in preventing slips/falls in gymnasiums appeared to be the type of footwear selected and worn (e.g., running shoes with flat soles that grip the floor).

Vancouver School Board - Year 2001/02

Total Falls	Same Elev.	Halls	Entra-nces	Class Room	Wash Room	Gym	Ramp	Stairs	Kitch-ens	Other
52	30	11	4	3	2	1	2	1	2	4

Note: As "Falls on the Same Elevation" are a subset of "Total Falls", so too are falls in specific locations in part a subset of "Fall on the Same Elevation". Therefore, the total of 30 "Falls on the Same Level " is the sum of the "Halls" through to "Other" category.

Vancouver School Board - Year 2002/03

Total Falls	Same Elev.	Halls	Entra-nces	Class Room	Wash Room	Gym	Ramp	Stairs	Kitch-ens	Other
41	18	5	0	5	0	1	0	0	2	5

Note: As "Falls on the Same Elevation" are a subset of "Total Falls", so too are falls in specific locations in part a subset of "Fall on the Same Elevation". Therefore, the total of 18 "Falls on the Same Level " is the sum of the "Halls" through to "Other" category.

Information extracted by the WCB following a Year 2001 review of 200 Surrey School District Employer Form 7s revealed (unpublished WCB data) confirms that hallways are a major source of slip/fall incidents - as are classrooms:

Surrey School District - Year 2001

Location of Slip/Fall Incident:	**Total Number of Slip/Falls:**	**Slips/Falls on the Same Elevation:**	**Slips/Falls as a % of Total Slip/Falls**
Hallways	28	12	43
Classrooms	40	1	3
Entranceways	3	2	67
Stairs	9	4	44
Shops	6	0	0
Gymnasiums	15	3	20
Total:	101	22	22

Miller (n.d.) rationalizes that, in the United States, the number of fatal falls has decreased, "*In 1940, there were 22 deaths per hundred thousand from falls; today that*

number has fallen to about 1.6.". However, Kendzior notes that, "*Are more people slipping and falling today than in past years…probably not but keep in mind…when a person accidentally fell back then, he did not think to file a lawsuit."* Nor did the families.

Why do people slip and fall?

As the CSPA ***Floor Safety*** article (2002) states, "*Walking is an enormously complex activity involving many muscles, bones and nerves, as well as kinesthetic sensory information that must be blended, graded and coordinated by the brain to transport the body from one point to another."* Although adult individuals no longer consciously govern themselves when walking, if there is a moment of inattention and, if there is an unobserved change in floor elevation, or if the surface is damaged or, if there is an unnoted contaminant present, the "*blended, graded and coordinated*" pattern of walking may be disrupted and a fall may ensue.

Goodwin (1999) observes that "*People consciously or unconsciously alter their walking styles to account for the perceived slipperiness…people often fall when stepping from a less slippery surface onto one which is more slippery because they have no opportunity to perceive the difference in slipperiness and have not changed their gait accordingly."*

English (1995) comments, "*People can walk safely on surfaces that are slipperier than ice, if they know of the hazard."* Di Pilla (2002) supports this English observation regarding lack of knowledge/awareness in that, "*Most slip-and-fall incidents happen when people slip on a floor they assume is dry."*

English (2002) notes that, "*...women in very high heels modify their gait so as to require less available traction for normal walking. They are in effect walking on their toes, and they take shorter strides."*

Knowing that people can act to prevent slips and falls, **why do people slip and fall**?

In Britain, in the catering industry (Slips and Trips, 1996), "*Slips account for about 86% of the total of slips and trips injuries. In 90% of cases the floor is wet."* (underlining added)

Goodwin (1999) describes the mechanism that promotes falls on a wet floor as, "*Many floors (especially smooth floors such as vinyl tile and terrazzo) will become dangerously slippery for some footwear when they are wet. This is due to a condition where at the moment of shoe touchdown, a fluid film is trapped under the shoe. This phenomenon, known as hydrodynamic squeeze film, is similar to an automobile hydroplaning."* In other words, the foot, as it descends, has no traction. An uncontrolled skid occurs. The person loses control and falls.

In British Columbia, the BC School Safety Association (Preventing Slips in Schools,

n.d.) describes another factor, "*Sand, bits of gravel and dirt are commonly called 'boulder dust' because they act as miniature ball bearings when caught between a hard floor surface and a smooth shoe sole."* The shoe loses its traction due to the "*ball bearing*" effect. The foot "*skids away*". The person loses control and falls.

In Britain, in healthcare, the British Health Services (Sheet No. 2, HSE, 1996) indicates:

> *The four main causes of slips and trips accidents in healthcare are:*
> - *slippery/wet surfaces - caused by water and other fluids;*
> - *slippery surfaces caused by dry or dusty floor contamination, such as plastic, lint or talcum powder;*
> - *obstructions, both temporary and permanent;*
> - *uneven surfaces and changes of level, such as unmarked ramps*
>
> *Other causes include factors such as poor level of lighting and external glare; human factors such as employees rushing; running or carrying heavy/cumbersome items; the wearing of unsuitable footwear or the use of improper cleaning regimens.*

Such factors are common to most slip/fall situations in North America.

Lemon (n.d.) adds, "*The data presented suggests that encumbrance increases the risk of pedestrian slipping. It is also suggested that 'off-centre' encumbrance (e.g., the carriage of bags via a shoulder strap) poses a higher slip risk than central encumbrance (e.g., a centrally positioned rucksack).*"

Why did the Panel focus its attention on slips that occur indoors and on the same level?

Slips and falls often result in serious injuries with long recovery times. Some people never return to gainful employment after a serious slip/fall.

Meserlian (1999) notes, "*There are approximately twice as many fatalities, 14 times as many hospitalizations, and eight times as many non-hospitalized injuries due to falls compared to fires and burns. The lifetime cost of fall injuries is approximately ten times the cost of fire and burn injuries. More than 60% of falls occur on level ground as a result of slipping or tripping.*

In New Zealand (Slip resistance of pedestrian surfaces, 1993), "*...New South Wales workers' compensation statistics for 1991/92 show that falls on the same level are responsible for 14.3% of male occupational injuries and 20.7% of female injuries.*"

In British Columbia, the BC School Safety Association reported (Preventing Slips in Schools, n.d.), "*Slips are a common source of injury in school districts. In the 5 years 1993 to 1997, 1,680 time loss injuries resulting from 'falls on the same level' were reported to the WCB…this accounts for 15% of all reported incidents and 17% ($7.5 million) of all injury costs. The average time lost through each of these accidents was 28 days.*"

An unpublished report by the Vancouver School Board (Angel, 1991) states, "*...5 years*

of data (1986-90) VSB recorded 885 time-loss accidents of which 177 were suffered by teachers. Of these 177 teacher accidents, 32 or 18% were 'falls on the same level due to slippery surface'…"

So, what is the situation in School Districts in British Columbia?

School Districts have a population dynamic that stretches from the very young (pre-school attendee), through the teenage years (high school attendee), into the middle years (the parent and teacher population) and, into the twilight years (elderly people who visit the school after-hours for various activities and social functions). The hazard of a slippery floor remains the same but the risk changes as the characteristic of the population changes (sometimes daily, sometimes hourly).

Young people slip and fall routinely, get up and walk away. Older people slip and fall less frequently but may not rise as quickly or, at all. Kendzior (2004) indicates that, in the United States, "*Each year more than eight million people seek emergency room treatment for accidental falls, the cost of which exceeds $60 billion…three million occur at a place of business…".*

An analysis of slip/fall incidents - unpublished information from the Vancouver School Board (Angel, 1991) - reveals a trend consistent with the literature.

5-Year Comparative Figures:

	1981-85	*1981-85*	*1986-90*	*1986-90*
Worker Group	***# Floor Slips***	***% of Total Accidents***	***# Floor Slips***	***% of Total Accidents***
VSB Teacher	*45*	*28.7*	*32*	*18.1*
Other BC Teachers	*125*	*10.5*	*140*	*12.3*
VSB Non-teacher staff	*54*	*8.7*	*23*	*3.2*
Other BC Non teaching staff	*421*	*7.3*	*387*	*6.0*

This information is supported by similar data collected in the British education system (Preventing slip and trip incidents, 2003):

Slip and Trip Incidents in Education for 1999/2000

Learning Institution Level	Reported Injuries	Injuries Due to Slips	% of Injuries Due to Slips
Primary & Secondary	4032	1382	34%
Higher & Further Education	2093	599	29%

And, is reflected in information collected in other BC School Districts (unpublished data):

For the Year 2002/2003:

School District	District Name	Reported Claims	Trip/Slip (on/over)	Loss Time Accident	Indoor/ Same Elev.
20	Kootenay	36	9	-	3
57	Pr George	-	26	-	9
60	Peace River	40	11	-	1
70	Alberni	58	10	3	2

Note: a) Most of the SD57 slip/fall reports were out-of-doors and involved ice/snow.
b) Roughly 40% of the falls on the same level specified wetness or debris as a possible cause.
c) Of the 11 trip/slip incidents in SD #60, 7 were teachers - all the falls were on wet floors.

Information provided by the WCB for *falls on the same level* occurring in Public School Districts in the period 1998-2002 (unpublished WCB data) indicates that there are occupations in the education field that slip and fall more frequently than others. In descending order of slip/fall incidents, these occupations include:

- Janitors & Caretakers: Custodian, Heavy Duty Cleaner
- Elementary School & Kindergarten Teacher, Primary School Teacher
- Secondary School Teacher: Substitute High School Teacher, Special Ed Teacher
- Elementary & Secondary School Teacher Assistants, Program Assistants
- Secretaries, Clerical Workers.

As the following table indicates - from information provided to the Panel by the WCB from a review of 200 Surrey School District employer Form 7s in Year 2001 (unpublished WCB data) - there is support for the overall occupation trend:

Occupation Type	Total - All Injuries Reported	Falls on Same Elevation	Falls as a % of Total Reported Incidents
Janitors	43	6	14
Teachers	52	14	27
Teaching Assistants	34	6	18
Clerical	8	2	25
Maintenance/Construction	35	4	11

The information provided by the WCB for *falls on the same level* occurring in Public School Districts 1998-2002 (unpublished WCB data) indicates that amongst females, the occupations with the most falls were Elementary, Kindergarten and Secondary School Teachers. Amongst males, the occupations with the most falls were Janitors/Caretakers and Secondary School Teachers.

A possible gender difference may exist.

An unpublished report from the Vancouver School Board (Angel, 1991) commented on what appeared to be a possible gender difference in respect to slips and falls, "*...recent VSB data available (1986 and 1990) show that female teachers have over twice the per capita risk of an inside floor slip compared with VSB male teachers i.e. 15.65 per 1,000 v. 6.67 per 1,000. The type of footwear worn may therefore be implicated as a significant causative factor."*

Information provided by the WCB for *falls on the same level* in Public School Districts for the period 1998-2002 (unpublished WCB data) reached a similar conclusion, "*females account for 68% of injuries while males account for 32%.*" Again, this supports the Vancouver School Board observation.

Information provided to the Panel by the WCB from a review of 200 Surrey School District employer Form 7s in Year 2001 (unpublished WCB data) supports the perception of a gender bias:

Gender	Total # Reported	Reported Falls on the Same Elevation	Falls as a % of Total Reported
Female	99	22	22
Male	90	13	14

The Surrey data indicates that, overall, more female workers fell; that more female workers fell "*on the same elevation*"; and, that the percentage of falls on the same elevation was higher for females.

A possible seasonal effect may exist.

An unpublished report from the Vancouver School Board (Angel, 1991) commented on what appeared to be a seasonal effect: "*...for VSB and other school districts, 40 to 42% of the inside slip/fall accidents occur in the four typical wet weather months…".*

Information provided by the WCB for *falls on the same level* in Public School Districts for the period 1998-2002 (unpublished WCB data) concluded that most slip/falls occur in the months of January, February and December. This statement tends to support the Vancouver School Board observation.

Data from the Workers' Compensation Board of British Columbia (WCB Annual Reports, 1998-2002) indicates the following cost statistics:

Note, before considering the table:

1) Although the WCB information does not specifically address slip/fall incidents, if, as the world-wide figures indicates, 15-20% of claims (total claims and claims cost) result from slips and falls, the cost to School Districts from this source would be substantial. Introducing controls that would prevent or, reduce, the frequency of slips and falls would save School Districts a significant amount (medical aid claims cost, time loss and pensions) not to mention the human saving (in disrupted family life and in pain and suffering).

2) In reviewing the WCB figures, the WCB abbreviations denote:

LTD	=	Long Term Disability
STD	=	Short Term Disability
HCO	=	Health Care Only
WL	=	Wage Loss

3) In reviewing the WCB information, the WCB term "*rate group*" denotes an artificially created association of employers placed together in order to have a base of "*insurable like companies*" - a base large enough to establish a premium figure and large enough to not suffer radical changes in premium should a single member employer have a significant compensation claim.

4) The WCB's accumulation of "*like employers"* includes sets of employers that School Districts would not ordinarily consider as being comparable to them.

5) Periodically, the WCB adjusts the set of employers in a rate group to better align with its insurance practices/needs and, therefore, it is difficult to make meaningful cost comparisons over time from this type of data (as the membership is not constant).

Comparison of Claims by Type and Cost for the Years 1998 - 2002

	Count of Claims			Type of Claim			
Year	All Claims	STD - WL Claims	Rate Grp	HCO	STD	LTD	Fatal
1998	179582	69431	1406	2807	2926	62	1
1999	178168	68671	1406	2733	2851	66	1
2000	184131	68362	7650	2341	2318	69	0
2001	172103	64165	7650	2368	2367	74	3
2002	159372	56410	7650	2168	2116	103	1

Year	Rate Group	Cost of Claims (by type)			
		HCO	STD	LTD	Survivor
1998	1406	$473,048	$10,907,935	$5,539,850	$30,900
1999	1406	-	$12,702,913	$6,915,891	$290,393
2000	7650	$520,895	$10,985,813	$4,345,557	$0
2001	7650	$517,466	$11,181,890	$4,773,895	$489,648
2002	7650	$537,717	$9,763,438	$5,327,926	$3,304

Note: Rate Group 1406 existed in Years 1998 and 1999 and included:

- Colleges, Kindergartens, Private Academic Schools, School Boards, Trade or Vocational Schools, Tutoring Services
- Library Boards
- Town Planning Boards
- Regional Districts engaged solely in Planning & Finance
- Acting Schools, Dance Schools, Driving Schools, Modeling Schools, Musi
- Social Service Agencies (Alcohol & Drug Centres, Community Service Ass
- Day Care Centres, Nursery Sachools, Playschools or Preschools

Rate Group 7650 existed in Years 2000, 2001 & 2002 and included:

- College, Trade School, or Vocational School
- Driving School
- Independent of Private Primary or Secondary School
- Library or Resource Centre
- Non-Academic School (not elsewhere specified)
- Public School District
- Tutoring Service
- University

What about falls on "slippery" floors.

"***The factors affecting traction between the shoe and the floor are (1) floor material and finish, (2) shoe bottom material and condition, (3) environmental contaminants present and (4) gait****."*, English (1995).

"*Slippery*" (or, "*slipperiness*") is a relative term. What appears slippery to one person may not be slippery to another. For example, many people equate a shiny floor with a slippery floor - surface luster has no direct connection with slipperiness.

In an attempt to have a "*term of reference*" that allows for more scientific comparison of "*slipperiness*" between floors, the Flooring Industry adopted a relative comparison ratio called the ***coefficient of friction***. Hermele (1999) describes coefficient of friction as "*…a dimensionless number being the ratio of the weight of an object divided by the force required to begin it's movement."*

There are two measures of *coefficient of friction* in common use: static coefficient of friction and dynamic coefficient of friction.

CSPA (Floor Safety, 2002) differentiates the two types of *coefficient of friction* measure as follows: "*The ratio of forces required to move one surface over the other under a given vertical force (e.g., the total mass of the pedestrian) is called the 'coefficient of friction'. When the coefficient of friction is measured from the rest position it is called "static" and when measured while the surfaces are in relative motion it is called 'dynamic'."*

Turner (Understanding the Coefficient, 2000) describes that difference as, "*The static coefficient of friction measures the amount of energy required to move a stationary object across a surface. The dynamic coefficient of friction measures the energy required to keep an object moving."*

Industry and Science dispute the relative relationship of the two measures due to the inability of either to adjust for the human component (of walking).

In the United States, favour falls toward measurement of static coefficient of friction whereas, in Europe, the focus is more toward measuring dynamic coefficient of friction. The Panel focused its activities around the North American perspective.

Market Analysis (2004) suggests the following measures as suitable coefficient of friction references:

The following chart is the scale for 'Static Coefficient of Friction'
.6 or above - Considered very safe (ADA recommended)
.5 to .59 - Considered safe (OSHA recommended)
.4 to .49 - Considered somewhat dangerous
.35 to .29 - Considered dangerous
.10 to .34 - Considered very dangerous

Coefficient of friction values vary between flooring materials and between floor coating treatments applied to the same type of flooring material. Some flooring materials have a higher coefficient of friction than others (as do coatings).

For example,

Slip-Resistance of Natural Floor Materials (Hermele, 1999)

Coefficient of Friction	***Dry***	***Wet***
Concrete (wood floated)	*0.96*	*0.73*
Concrete (metal toweled)	*0.74*	*<0.5*
Stone	*0.79*	*0.63*
Asphalt (high texture)	*0.78-0.85*	*0.63-0.67*
Ceramic tile	*0.71*	*<0.5*
Brick	*0.5*	*<0.5*
Terrazzo	*0.44*	*<0.5*

The coefficient of friction also varies according to the test medium in use when performing the measurement and, if the surface is wet or dry. Keyserling (2000) offers the following chart:

	Test Medium (test pad)	
Surface	*Leather*	*Neoprene*
Vinyl Asbestos, Dry	*.46*	*.58*
Vinyl Asbestos, Wet	*.30*	*.63*
Linoleum, Dry	*.27*	*.42*
Terrazzo, Dry	*.25*	*.38*

CSPA suggests (Floor Safety, 2002) "*…that people would not slip if they walked on a floor having a coefficient of friction as low as 0.3 to 0.45, depending on the individuals."* The Australian/New Zealand standards (Slip resistance of pedestrian surfaces, 1993) appears to recognize this fact as, in Australia and New Zealand, the requirement for wet or dry surfaces is a mean coefficient of friction of 0.4 or greater using a pendulum friction tester (where no specimen in the test population has a coefficient of friction less than 0.35).

The "*accepted safe coefficient of friction*" value in North America is 0.5.

English (1995) explains that, "*It is not primarily the coefficient of friction of a floor surface that determines its safety for walking. It is usually a localized spot that is slipperier than the rest of the floor that causes the unsuspecting and unprepared pedestrian to slip and fall."* And, English (1995) points out that "*No inferences concerning the safety of a surface while in a wet or lubricated state can be made from traction measurements performed on it while it is dry."*

The Hartford Group (Preventing Slips and Falls, 2002) indicates that, "*Fewer slip and fall accidents occur on wood floors than on other types of floors….Wood floors generally become dangerous when unsafe sealants are applied or when they are oiled."*

The Hartford Group also comments, "*Walkway surfaces which have been painted with floor and deck paints can present serious slip and fall hazards. Most paints produce surfaces which are below a .50 coefficient of friction and are therefore dangerous."*

Clearly, a "*safe*" walking surface can be innocently altered to become an "*unsafe*" walking surface by an inappropriate choice of floor treatment. It is also sometimes risky to apply products from two separate manufacturers on the same surface (e.g., a floor stripper from one manufacturer followed by a coating from another manufacturer).

How is coefficient of friction measured?

When discussing the measurement of floor "*slipperiness*" or, the measurement of "*coefficient of friction*", Hermele (1999) introduces the science of tribology where "*The field of tribology (from the Greek, tribos = rubbing) concerns the nature of friction, wear on surfaces, chemical and physical effects, and adhesion at the interface.*".

A device that is used to determine the coefficient of friction is called a "*slip meter*" or a "*tribometer*".

Di Pilla and Vidal (2001) indicate that *"A recent count (1996) identified at least 70 different slip meters that have been invented…of the most widely used slip-resistance measurement devices (tribometers) only two have sufficient credentials to be used on dry and contaminated surfaces…Currently, only two devices have an ASTM F-13 standard for wet testing: the portable inclinable articulated strut tribometer (PIAST, aka Brungraber Mark II) and the Variable Incidence Tribometer (VIT, aka English XL).* They go on to state*, "ASTM currently has eight active standards for six different slip meters…approved only for specific uses…"*

Therefore, different types of tribometer are used to measure coefficient of friction on different surfaces. Different types of tribometer may be used to measure coefficient of friction on the same surface depending if the surface is dry or wet. And, different types of tribometer may be used to test flooring samples in the laboratory versus in the field.

Sacher (1993) states "*…ASTM D 2047-75 became (and remains to date) the first and only voluntary consensus standard specifying a compliance criterion, namely, 0.5 static coefficient of friction…"* Owen (2002) indicates, "*SCOF has become the common performance measurement for slip-resistance in the United States and has been adopted by the National Bureau of Standards, OSHA and the ADA. Most codes recognize a SCOF of .5 as a threshold of safety. The ADA has determined that some disabled persons require higher values. .6 on level surface and .8 on ramps."* Tribometers are the only device available to assess whether a suitable slip resistance exists.

Kindlier (1999) offer some examples of the different types of tribometer available:

Device	**SCOF**	**DCOF**	**Other**	**Port**	**Degree of Accuracy**	**Wet**	**Dry**	**Oil**	**Cost (US $)**
James Machine									
James Machine	X			No	High		X		15,000
Horizontal Dynamometer	X			Yes	Moderate	X	X		2,250
Tech Prod Model #80	X			Yes	Moderate	X	X		1,000
Brungraber Mark II	X			Yes	Low	X	X	X	4,300
English XL	X			Yes	Low	X	X	X	3,200
Sellmaier FSC 2000	X	X	X	Yes	High	X	X	X	3,000

Note: *SCOF* denotes a device to measure *static coefficient of friction*
DCOF denotes a device to measure *dynamic coefficient of friction*
PORT denotes a device that is *portable* (versus one that is non-portable)
Wet, Dry or Oil denotes the ability of a device to give a reliable reading under those conditions of measurement

The James Machine is considered the *Industry Reference Standard* for tribometers.

Sacher (1993) indicates that the James Machine was first identified to Industry at the Chemical Specialties Manufacturers Association Meeting in 1944 in a paper by Sidney V. James of Underwriters Laboratories Inc. entitled, "*What is a Safe Floor Finish?"*. In 1945, James proposed to the Casualty Council of Underwriters Laboratories Inc. that a safe value of coefficient of friction could be established using the James Machine - the suggested coefficient of friction value was 0.5. It wasn't until 1964, however, that the ASTM established ASTM D-2047; in 1969, the James Machine became the ASTM testing standard.

ASTM Standard D2047-82 (1982) makes the following statement about the James Machine:

> *This method covers the measurement of the static coefficient of friction of floor surfaces for the James Machine. The apparatus is not suitable for use on wet, rough, or corrugated surfaces. The apparatus is suitable for laboratory testing.*

As there is a need to perform in-field slip-test measurements on wet, rough and corrugated surfaces, work was undertaken to identify portable slip-test measurement devices. CSPA reports (Floor Safety, 2002):

> *This program reviewed, among many others, Liberty Mutual Horizontal Pull Slip Meter, Sigler Machine, Topaka Tester, Tortus, Brungraber Mark I and the newer Mark II, the English XL (VIT), and the James Machine. Of these, only the James Machine which measures static coefficient of friction, was found to consistently and reliably simulate the events that occurs when a person actually walks on the floor surface. No other test measurement for measuring coefficient of friction correlates with the values obtained from using the James Machine."*

English (1995) reports, "*All drag-sled meters and the traditional articulated strut instruments give misleading results on wet surfaces and are useless for safety engineering studies where surface contaminants are present."* The Buckeye Company (Bulletin Number 1397, 1997) confirms English's position, "*...Of all the portable slip resistance testers on the market today, none correlate between themselves and none correlate with the James Machine. What this means is that two different brands of portable slip testers will yield two different numbers."*

One of the difficulties in achieving a reliable and consistent tribometer reading on wet surfaces is a physical phenomenon known as "*sticktion*". Di Pilla and Vidon (2001) describe sticktion as "*'Sticktion' is the result of water being squeezed out of the interface (between the test foot and the walkway surface) creating a temporary bond between these surfaces."* So, for a brief period, the shoe sole material is held to the floor by the water (artificially increasing the coefficient of friction measurement).

The lack of correlation between makes and models of tribometer and, the inability of some tribometers to provide a measurement on surfaces that are rough, wet or corrugated, makes meaningful data collection and exchange difficult. To overcome some of this difficulty, different countries have proposed different solutions.

<u>In Britain</u> (Preventing slip and trip incidents, 2003), "*The most common method of measuring slip resistance uses a 50-pound weight placed on flat on a Neolite shoe heel which is then placed flat on the stone surface being tested. The heel and weight assembly are pulled across the stone with a spring or electronic scale. The maximum amount of force (pounds) needed to start the assembly in motion is recorded. The measurement is divided by the weight (50 pounds) and yields the coefficient of friction value."*

<u>In North America</u> people have tried a number of slip-test measurement devices. One of

these devices, the Topaka Floor Slip Tester has been used by the Vancouver School Board for a number of years. Topaka Scientific Safety (1984) describes their test unit as, "*The TOPAKA Floor Slip Tester…designed for use by non-technically trained operators. Dynamic coefficient of friction is read directly from the scale, no calculations are necessary…"*

In Australia, the Australian/New Zealand Standard (Slip resistance of pedestrian surfaces, 1993) includes reference to building your own pendulum testing device and provides construction standards for building your own device.

One Vancouver School Board Panel member had prior experience performing slip-test measurements of floor sample materials in a testing laboratory; the other Vancouver School Board member on the Panel had hands-on field experience performing slip-test measurements on flooring in schools with a portable device (the Topaka). Both Vancouver School Board members reinforced that it is difficult to correlate data between devices from different manufacturers. Vancouver School Board informed the Panel members that it decided overcome this problem by focusing its attention on a single device, the Topaka Floor Slip Tester. Collecting results using this one type of device allowed for reasonable comparisons of data between work circumstances over time. The Vancouver School Board Panel members indicated that they have been conducting slip tests for a number of years and they reported to the Panel that they were quite satisfied with the Topaka apparatus as an in-field slip-test device.

Other School Districts have hired outside consultants to take measurements.

For example, a consultant generated the following set of slip test data (unpublished data, 1992) for School District No. 39. The test was actually a test to determine which floor treatment product provided the best slip resistance to various shoe sole material under wet and dry conditions. The results, however, illustrate coefficient of friction change. The data indicates how shoe sole material factors in to the problem of floor slip-resistance and how the shoe sole material changes the impact of floor resistance when the floor is wet versus being dry.

Surface	Finish	**Dry**			**Wet**		
Material	Applied	L	P	R	L	P	R
Linoleum	1	.25	.32	.48	.51	.30	.81
Linoleum	1	.26	.32	.46	.52	.30	.83
Linoleum	2	.26	.38	.60	.51	.31	.79
Linoleum	2	.26	.38	.62	.50	.30	.81
Tile	1	.32	.44	.61	.55	.40	.84
Tile	1	.33	.44	.63	.57	.41	.86
Tile	2	.41	.46	.73	.58	.41	.83
Tile	2	.40	.45	.69	.56	.41	.79

Note: a) Tests were performed on 8 panels using a friction test block made from different materials (leather, plastic and rubber).

b) The letter "L' stands for leather test block; "P" for plastic; and, "R" for rubber.
c) The Consultant followed CAN2-75.1-M77 when testing.
d) A test value greater than 0.50 would be used to denote "slip resistance".
e) The leather test block performed better on a wet surface than it did on a dry one; the hard plastic block performed poorly on both wet and dry surfaces; the rubber block performed well on both wet and dry surfaces.

Kindlier (2004) identifies that, "*In 2001 the NFSI introduced a state-of-the-art testing device called the Universal Walkway Tester (UWT). This fully robotic device...is portable and can measure walkways as they exist in the real world. The UWT was designed to measure a floor's slip resistance when wet, which is the condition in which most slips and falls occur.* (NFSI is the National Floor Safety Institute). Although the UWT appears to be an exciting breakthrough in testing technology, it will be years before it (or, a more commercial version of it) will be available for general testing purposes. Until that time, tribometer technology will remain the tool of availability and convenience.

How to choose the right floor material?

In *Education Information Sheet No. 2* (HSE, n.d.), the British suggests that slip/trip situations should be addressed proactively, "*Where changes or modifications to premises are to be made, education employers should ensure that consideration is given to eliminating slip and trip risks during the design stage of the changes - for example, installation of a slip-resistant floor."* Choosing the right floor material for the environmental conditions of use will prevent much of the potential slip/fall problem

Choosing the right floor requires careful consideration of environmental conditions, pedestrian use patterns, inherent properties of the flooring material, and inherent properties of floor finishes (when applied upon a flooring material).

School Districts have a unique problem in respect to pedestrian use pattern. Hundreds of students tread over the same general floor area at the same time (between class changes) and the process is repeated several times each day (as classes change). Few other Industries face such a concentrated and continuous use pattern. As well, students tend to be channeled into certain passageways so the flooring in one passageway becomes more worn than other passageways in the same building. Facing such a problem, choosing the right flooring material is a challenge.

The Hartford Group (Preventing Slips and Falls, 2002) offers advice about various types of floor tile material:

> *Terrazzo tile is composed of granite and marble chips bonded with cement…The common varieties of terrazzo have very low coefficients of friction and are therefore very slippery…Terrazzo is especially slippery under wet conditions…Terrazzo floors in high traffic or public places should never be waxed…Some terrazzo tiles contain non-slip additives…When proper floor maintenance procedures are followed, non-slip terrazzo floors are generally safe under both dry and wet conditions.*
>
> *Virgin tile, such as quarry tile, has a generally high coefficient of friction; when properly maintained, it offers a relatively safe surface. Virgin tile is often sealed after installation. Many sealants give the virgin tile a ceramic appearance and also a low coefficient of friction….Glazed tiles are not appropriate for high use walkways because they have low anti-slip coefficient of friction values…*
>
> *Vinyl and vinyl asbestos tile are plastic or plastic-containing floor surfaces…plastic sheet tile surfaces have very low coefficients of friction. Floor products that combine cleaner and wax are not acceptable for commercial pedestrian traffic areas because of the build-up of residue that naturally occurs with their use…The application of 'non-slip' wax dressing without buffing is highly recommended for these floors.*

Janitors' Warehouse (Floor Problems, n.d.) indicates that there may be problems with certain types of tile under use conditions: "

> *All vinyl bonded floors employ plasticizers in the manufacturing process…The tougher the resin, the more difficult it is to plasticize. Since vinyl is so tough and obstinate, vinyl bonded tiles necessarily contain a great deal of plasticizer…it may take a year or more before the excess plasticizer migrates out of the tile. While it is still migrating from the tile, it will tend to soften the film finish. On floors with a high plasticizer content, table legs and chair legs may tend to stick…Floor finishes may tend to remain tacky…*

Janitors' Warehouse (Flooring, n.d.) describes the nature of certain flooring materials and warns of some of the substances to avoid when working with the materials.

Floor Type	*Composition*	*Issue*
Vinyl	*Vinyl resins as the binding agent; can be made with asbestos fibers (vinyl asbestos tile), flexible vinyl tile (laminated on a flexible backing) or calendared vinyl Flooring (like a linoleum)*	
Asphalt	*Asbestos fibers mixed with pigment, inert fillers together with asphalt*	*Avoid oil & solvents*
Concrete	*Portland cement with sand, gravel and*	*Avoid harsh cleaners*

	water	*& acids*
Wood	*Softwoods & hardwoods*	*Unless sealed, avoid water - avoid strong cleaners*
Terrazzo	*Marble or granite chips mixed with Portland cement*	*Avoid harsh acids & alkalines*
Ceramic tile	*Clay & water mix/shaped and fired*	*Avoid harsh cleaners*
Linoleum	*Ground cork, wood flour, resins and colourant with linseed oil compressed onto a asphalt-saturated felt, burlap, jute or other backing*	
Marble	*Calcium carbonate changed by nature through pressure and heat into crystalline form*	*Avoid acids*
Cork	*Ground cork bark molded and Compressed under heat*	*Avoid water*
Rubber	*Natural, synthetic or reclaimed heated and rolled under pressure*	*Avoid oil & solvents*
Poured floors	*Synthetic urethane and epoxy resins poured in place*	

The Janitors' Warehouse representative who spoke to the Panel used, as an example of poor practice, applying a floor treatment over quarry tile. The representative indicated that quarry tile should not be treated but customers do so to protect the grout.

How to choose the right floor treatment?

Once the best floor for the use situation has been decided and, once the flooring has been installed, it is necessary to maintain the coefficient of friction.

McFadden (1993) indicates that, "*High-quality floor finishes may contain as many as 25 ingredients…Floor finish ingredients fall into five basic categories: polymer emulsions, film formers, modifiers, preservatives and water…most floor finish polymer emulsions are made from acrylic or styrene-type monomers…".* The more polymer in the formulation, the more durable the coating.

Interpolymer Corporation (The Inside Story, n.d.) states "*…water is by far the most common component of a floor polish formulation, amounting to approximately 80% of the total weight of a floor polish as it is manufactured…the drying process is the evaporation of water and the other volatile components and the formulation of a film.* The water needs to evaporate from the polish formulation in order that the finish will harden. The School District #60 Panel member indicated that, in winter, temperatures may drop to 20^0 below zero Fahrenheit at doorways - this impedes the drying process. The literature suggests that a room has to be above 56^0 Fahrenheit before the polish will bond properly to the substrate. In winter, in colder areas, School Districts practice heat

conservation. Custodial personnel may be required to turn the temperature down in the evenings before they leave for the night (and, after applying a fresh coat of polish). As some coatings require up to 24 hours to set, the low overnight temperature may not permit the coating to harden properly.

In summer, humidity may present a problem. Too high a humidity will also affect the set-up time. The Panel member from School District #8 indicated that they overcome this problem by setting the HVAC system to control humidity at 38%. The Vancouver School Board Panel members indicated that they set the humidity at 50%.

Interpolymer Corporation (The Inside Story, n.d.) describes the components of a floor finish and their function (underlining added):

> *The polymer, which is the predominant active component, accounts for 60-80% of the material in the dry film…the polymer in the wet polish consists of spherical emulsion particles ranging in size from 0.1 to 0.5 microns…stabilized by anionic and nonionic surfactants……multivalent metal complexes…serve to cross link the polymer during the final stages of the drying process……polyethylene or wax emulsion particles…impart buffability and scuff resistance…alkali-soluble resin…enhance gloss, leveling and, by virtue of their alkali-solubility, removability…silicone emulsion defoamer…is absolutely necessary if polish is to be applied to the floor without the retention of foam bubbles and an unsightly appearance…Wetting agents, also used in very small quantities, act to reduce surface tension…and thereby assure improved flow and leveling characteristics…Stabilizers protect the polish during shipping and storage from increases in viscosity or destabilization caused by high temperatures or freezing…The use of biocides in floor polishes is critical in protecting against the growth of bacteria, fungi, and yeasts…*

Interpolymer Corporation (Table 1, The Inside Story, n.d.) provides definition of a typical floor polish formulation (20% solids):

% Solids in Formulation	Description	Parts by Weight
	Water	45.0 +/- 5.0
13	Polymer emulsion	35.0 +/- 5.0
4	Polyethylene & wax	10.0 +/- 5.0
1	Alkali-soluble resin	5.0 +/- 5.0
Politicizes & Coalescents:		
1	Tributoxyethyl phosphate	1.0 +/- 0.2
1	Permanent	1.0 +/- 0.5
0	Fugitive	3.0 +/-1.0
Minor Component:	Defoamer/Stabilizer/Biocide	

Interpolymer Corporation (The Inside Story, n.d.) adds, "*There are two types of*

plasticizers: permanent and fugitive. The fugitive plasticizers are also referred to as coalescents…Permanent plasticizers…are absorbed completely by the polymer and other solid components upon drying and remain in the film to provide continuing plasticization…Coalescents…which volatilize during the drying process, are used to temporarily lower the MFT of a polish…" (the abbreviation MTF stands for the Minimum Film Formation Temperature)…"*A polish without plasticizers may dry to a powder and become a totally useless product."*

Varying the ratio of floor treatment ingredients may serious affect the ability of the product. For example, Interpolymer Corporation (The Inside Story, n.d.) states, "

> *Resilient tile with a high filler content , or older linoleum can absorb some of the coalescents and plasticizers from the polish, thus reducing the amount available for film formation. The use of a properly formulated sealer before applying polish is generally effective in remedying this condition.*

And, Interpolymer warns,

> *…after approximately five minutes sufficient water has left the wet film for the polish to begin to solidify…In about 20 minutes, the polish film is dry to the touch and most of the complex process of film formation has taken place…A small amount of fugitive plasticizers and trapped water still remains in the film, but this does not usually interfere with the application of the next coat in 30 minutes. However, if too many coats of finish are applied in 30-minute intervals, the amount of retained fugitive plasticizers and water may increase so much that trouble-free recoating will not be possible.*

The Old House Web (Finish for Wood Floors, 1998) describes some of the popular treatment finishes, their advantages and disadvantages.

Type of Finish	**Description**	**Advantages**	**Disadvantages**
Water-based Urethanes	Combination of urethanes and acrylic catalysts	Less volatile organic compounds; clear; fast drying; non-flammable	Slightly less durable finish; adherence may be an issue between coats
Oil-Modified Urethanes	Technically, oil-based urethanes	Requires fewer coats (than water-based); easy to recoat	Yellowier cast; may require sanding between coats; high volatile organic content
Moisture-Cured Urethanes	React with humidity in the air to dry	Durable; hard wearing; recoatable	Difficult to apply; only gloss finish; high level of volatile organics; flammable

"Swedish" Finishes	Acid-cured	Durable; transparent; elastic; fast drying; recoatable	Difficult to apply; high volatile organic content; contains formaldehyde; combustible Linseed or tung oil with additives to improve drying and hardness
Oil Finishes	Linseed or tung oil with additives to improve hardness and drying time	East to apply/repair; low luster	Less durable; long curing time; strong initial odour; combustible
Waxes	Paste waxes	Protects and extends life of oil finishes; easy to apply; fast drying	Requires maintenance; slippery when wet; strong initial odour

Buckeye International (1997) comments, *Another problem is a lack of floor finish to properly cover the surface. If the floor coating does not create enough 'thickness' then the anti-slip properties will never fully be achieved regardless of the quality of the maintenance program…"*

How can a floor be made less slippery?

Sacher (1993) defines **slip resistance** as "…*that property of a surface which denotes its ability to withstand or give protection against a slip…Slip resistance is neither a constant nor an intrinsic property of a given surface composition…but, instead, varies with texture, wear and contamination…whether one is walking naturally, walking fast or running, turning sharply, pulling or pushing a load, or going up or down an inclined plane or steps, coupled with the psychological, perceptual and behavioral condition of the individual.*

ASTM D2047-82 defines **slip resistance** as "…*that property of a floor surface which is designed to prevent slipping. A surface having a static coefficient of friction of 0.5 or greater as measured in accordance with this test method is considered to be a slip-resistant surface."*

Floors can be made less slippery (more slip resistant) in a variety of ways.

Buckeye International (Buckeye International, 1997) indicates that "*Anti-slip properties are formulated into a floor finish and formulations are thoroughly tested to verify slip resistance prior to being placed in the market and are guaranteed to meet or exceed the minimum tests requirements as established by ASTM Standard D2047*." So, if a School District purchases a product from a reputable manufacturer, the District could assume that the product - applied properly - will meet the 0.5 coefficient of friction standard.

School Districts, however, have a duty to question how a floor coating product actually performs in a use circumstance immediately after application and as the product wears. The only way a School District can discharge that duty is to take measurements.

Hermele (1999) notes, "*Today's new classes of Anti-Slips are generally epoxy and contains aluminum oxide…These coatings can raise the coefficient of friction from 0.5, which is OSHA's minimum for smooth floors to greater than 1.20."* Owen (2002) indicates that the anti-slip property of these coatings arises as, "*The most effective particles for increasing slip-resistance have an angular configuration and increase surface roughness. These particles must extend up through the water or contamination on the surface and effectively engage the shoe bottom."*

School Districts need to consider the use of such anti-slip materials. A factor to consider is the transition effect - moving from one surface treatment to another. Although a pedestrian may not fall from slipping on the anti-slip treated area, the pedestrian may fall when the anti-slip coating causes the foot to hold fast where some surface slide is an expectation. The sudden stop when moving to the non-slip area can unto itself cause a loss of balance.

Bowman (1997) indicates that the floor material itself can be modified to make it less slippery, "*Floors intended to be used in wet areas, such as swimming pool surrounds, are often profiled…firstly, it helps to drain water away and secondly, it helps soft shoe materials or bare feet to obtain a better grip…profiled floors in wet conditions are safer than flat floors…"*

The Australian/New Zealand Standard (1994) provides examples of treatments that may be made to existing flooring materials after installation to reduce the level of slipperiness.

Surface	**Acid etch**	**Sand Blast**	**Grind**	**Paint & Sand**	**Groove**	**Floor Sander**	**Prop. Treat.**	**Adhere Strip**
Concrete	X	X	X	X	X			X
Ceramic		X	X	X	X		X	X
Granite		X	X		X		X	X
Wood				X		X		X
PVC							X	X

Floors can be treated with a coating material that reduces its level of slipperiness.

The Slip-Stop Company (Slip Stop, n.d.) describes its anti-slip product as "*Slip Stop' is a chemical, which, when applied to any siliceous surface such as ceramic tile, terrazzo and quarry tiles, cement, or porcelain, etc., will reduce slipping for a minimum of five years...a CHEMICAL REACTION which changes the surface (but not the appearance) of the tiles."* Slip Stop offers an illustration of its product's success with two types of shoe sole material (before and after treatment with the product):

	Tile Coefficient of Friction			
	Untreated Tile		*Slip-Stop Treated*	
	Dry	*Wet*	*Dry*	*Wet*
SBR (rubber)	*0.77*	*0.16*	*0.80*	*0.40*
Leather	*0.28*	*0.15*	*0.45*	*0.37*

Buckeye International (1977) reports:

> *Even though a floor is slip resistant as tested according to laboratory testing methods, in real situations a floor can become slippery. Usually, one of the following reasons impacts the slip resistance of a floor:*
> *- Water or other foreign substances on the floor. This includes furniture polish and other silicone polishes as well.*
> *- Finish is worn away. The re-application of additional floor finish actually increases slip resistance.*
> *- Foreign material on a person's shoe prior to stepping on the floor."*

The Australian/New Zealand Standards (Slip resistance of pedestrian surfaces, 1994) indicates that:

> *"Flooring and other surfacing materials in common use usually have acceptable slip resistance provided they are:*
> *(a) Dry.*
> *(b) Clean.*
> *(c) Free from oil, fat and other slippery substances.*
> *(d) Where required, maintained with a slip-resistant polish or finish."*

Heuston (What is the Coefficient of Friction, n.d.) offers some suggestions for procedures that building owners, cleaning companies and others can use to minimize the risk of slip/fall accidents. These include:

- Pay attention to areas where water and/or spills occur - clean up spills as soon as they occur; use mats at entranceways.
- If the floor is maintained by stripping and waxing, perform the procedure at night when there is minimal traffic; daily wet mopping should also be performed at night.
- Place '*wet floor*' signs in all areas where/when floor cleaning is underway.
- Keep accurate records of the products in use (including specific procedures performed, how often and who performed the work) and, maintenance procedures

Slippery floors can be covered:

To reduce the slipperiness of flooring surfaces, they can be covered with carpeting or with mats. Mekeel (2003) indicates "*All carpeted areas should be in good condition and should be uniform to provide a consistent and level walking surface for all personnel. The use of shag carpeting should be discouraged because heels are easily snagged in it.*"

And, Mekell notes, "*Walk-off mats, in good condition, should be provided at school entrances. Mats should have beveled edges to prevent them from becoming turned up, which could lead to a 'trip/fall' injury. Mats should be as wide as the doorway and extend approximately 15-25 feet inside the building, if possible.*"

The Panel member from SD #60 remarked that they have never had a slip/fall on carpeting.

Contaminants can be kept off the floor:

The School District #60 Panel member reported that the schools in the District have "*mudrooms*". Students entering the school remove their soiled footwear in the mudroom and put on clean footwear before entering the building. As well, schools have adopted a "*2-footwear policy*" in gymnasiums. No street shoes are permitted in gymnasiums.

Why is a clean floor so important?

CSIRO in Australia (Aussies Need 'Roadworthy' for Shoes, 2000) illustrates the problem with cleanliness, "*A 1990 study of public liability incidents revealed that 76% of actions were due to slips and falls. Eighty-six percent of these actions were classified as preventable and of these 77% were related to cleaning.*"

Buckeye International (1997) comments, "*...There are several basic maintenance steps that greatly increase anti-slip properties of a floor. The most important issue is debris on the floor. Most problems with floors result from inadequate mopping or cleaning. A significant reduction in debris can be achieved by a complete matting program.*"

The Hartford Group (Preventing Slips and Falls, 2002) indicates,

> *The procedure and products used to clean and maintain floor surfaces are sometimes a direct cause of many 'slip and fall' accidents. Maintenance staff may not have proper instruction and training in floor care, may fail to follow manufacturers directions when cleaning and applying finish, or may not understand that specific types of floors require specific types of care. Many of the best cleaning and finishing materials can be hazardous when applied improperly, and using the wrong product for a specific surface can create problems. It is critical that the right product be used on the right surface, for the right reasons, and under the right conditions.*"

Murphy and Lissome (2003) note that "*Without an effective cleaning procedure, a key benefit of textured flooring - increased coefficient of friction - is quickly lost. The maintenance regimen for such areas is twice daily cleaning plus regular touch-ups for spills."*

Goodwin (1999) confirms the value of cleaning, "*Data collected from a test restaurant indicated that one deep cleaning per month was adequate to maintain acceptable COF readings for 30 days."* This deep cleaning was supplemented with routine daily cleaning.

An unpublished report from the Vancouver School Board (Angel, 1991) states, "*It is a longterm VSB experience that most floor finishes when applied correctly to a compatible floor surface and kept clean, will produce a good anti-slip walking surface for appropriate footwear. Wet floors, dirty floors and areas where the applied floor finish has worn thin, are the most likely slip hazard sites."*

The Panel members all agreed that autoscrubbers were superior at cleaning floors. It was also agreed that high-speed burnishing was not an effective means of floor cleaning. This is supported by Owens (n.d.) who states, "*We have found that soiling and black marks are not to be repaired by high speed burnishing because these film defects act as lubricants to the high speed burnishing pad…High speed burnishing is not a good cleaning operation."*

Owens (The Physical Process, n.d.) notes that "*If a floor polish has been properly formulated and properly applied to the flooring…pedestrian traffic…in a very dirty environment, will cause soil to be beaten into the polish surface to a depth of 0.2 to 0.4 microns"* Owens found that *"…polishes with a KHN less than 2 to be impregnated with soil up to 2 microns deep (almost the thickness of one coat of dried polish film)"* whereas, *"…polishes, which have a KHN of 3 to 12, show soiling as a simple surface modification…"*

Rohm & Haas (Test Method, 1990) identifies KHN and assigns a reference value to certain treatment products,

> *A Tukon Microhardness Tester which consists of a load applicator, an indenter, and a microscope, is the tool used for determining film hardness…Hardness measurements are made on the polish film at one day, three days and seven days as the film is aged at constant temperature of 70^0 F, and relative humidity of 55 percent…Five hardness determinations are made at different places on the film each test day. An average of the five determinations is reported as a Knoop Hardness Number (KHN)…Knoop Hardness Numbers increase in magnitude with increase in hardness. Cured emulsion films generally fall in a range of less-than-one to 20 KHN. In comparison, shellac has a hardness of 13 to 15 KHN and the hardness of Carnauba wax is 7 KHN.*

Then, choosing a floor coating material with a high Knoop Hardness Number will result in a surface treatment that will resist soil damage.

Industry tips for floor cleaning.

Janitors' Warehouse (Floor Problems, n.d.) states, "*The success of any floor finish will depend more on preparation than on any other factor."*

Interpolymer Corporation (The Inside Story, n.d.) indicates that *"The most common cause of low initial gloss is improper floor preparation. Inadequate stripping and/or rinsing will leave a residue that interferes with the film formation process…using floor 'neutralizers' can leave the floor coated with residual acid, which reacts with the alkaline components in the polish causing instability and improper film formation."*

Janitors' Warehouse (How to Strip Floors, n.d.) discusses floor stripping techniques, "

> *Note: hot water can loosen tile adhesive and cause solutions to dry too fast.*
>
> *In the final rinse add commercial neutralizer per the instructions, if available. If not, use ½ pint of household vinegar to 2 gallons of water. A neutralized floor gives a much better bond of the finish to the tile…Allow floor to dry at least one hour after final rinse. Check floor to be sure it is ready for finish by wiping the hand across a section of the floor. If a white powder comes up, the floor has not been rinsed properly and must be rinsed until no white powder comes up after the floor is dry.*

Janitors' Warehouse (How to Care for Floor Pads, n.d.) discusses the proper use of floor mops:

> *Mops*
> *Most synthetic mops heads contain a fiber coating which makes the mophead less absorbent. Also, new cotton mopheads do not absorb as well as they do after some use since their fibers are still coated with natural oils. Therefore, before using a new mop, wash it in soap and tepid water and rinse well.*
>
> | *Best for* | *Mophead Yarn* |
> |---|---|
> | *Floor drying* | *Cotton* |
> | *Leaving less lint* | *Rayon* |
> | *No breaking in time* | *Rayon* |
> | *Wetting* | *Rayon* |
> | *Laundering* | *Blends* |
>
> *Note: When buffing between applications of coats of finish be sure to mop the floor with a dry dust mophead before applying the next coat. Buffing between coats is to level the finish.* (How to Finish (Wax) Floors, n.d.)

Reminder: A buffable finish can be applied on top of a non-buffable finish, but a non-buffable finish cannot be applied on top of a buffable finish.

The Victoria School District Panel member spoke to a problem of mop treatments. Custodians often apply a mop treatment to a mop to assist with the pick-up of dust (particularly, boulder dust). A common spray treatment for mops contains banana oil. If a Custodian sprays the mop and then uses it, the banana oil contaminates the floor and increases the slipperiness. Mops may be commercially cleaned and returned to the District for Custodial use or, the mops can be cleaned on site and then treated. However, if treatment is performed on site, it is necessary to wait 48 hours before using the mop. The Vancouver School Board Panel members reinforced these comments and indicated that, in an attempt to avoid contaminating floors with freshly treated mops, they had decided to use wetted sawdust to capture and control boulder dust.

Janitors' Warehouse (How to Care for Floor Pads, n.d.) also discusses floor pads:

Floor Pads
Since floor pads are made of different materials, using the correct cleaning method for each type of pad is important.
1. For natural fiber pads (hog hair), clean by using the centre die cut piece from the pad or a medium bristle brush and brush away the accumulation from the pad.
2. For a polyester or nylon pad use one of these three methods:
a. soak the pad in stripping solution until dirt is softened or loosened, then rinse using a water base.
b. wash under high pressure water.
c. launder in luke warm water.
Hang the pads in a storage area to dry after cleaning them.

But what about footwear?

English (1995) indicates (underlining added), "*The factors affecting traction between the shoe and the floor are (1) floor material and finish, (2) <u>shoe bottom material and condition</u>, (3) environmental contaminants present and (4) gait. The only factors under the control of the building owner are typically floor material and finish."*

The composition of the sole of the shoe (i.e., leather, neolith, rubber) and the condition of that sole material (i.e., badly worn tread, tread clogged with debris, etc.) can significantly alter the risk of a slip and fall. English (2003) points out that,

"*A slip meter only measures the traction properties of the floor. Its output is not relevant to any particular shoe except the Neolite pad is within the range of shoe bottom materials commonly used…because our slip meter friction pad is artificially prepared so that it is pristine and uniform each time it is applied to the*

test surface, it is giving us readings that are a bit higher than would occur under most normal (soiled) conditions.

In Britain (Preventing slip and trip incidents, 2003), employers in the education area have attempted to intervene to reduce the likelihood of slips and falls by controlling the type of shoe that is worn. The HSE Education Sheet No. 2 states, "*Footwear plays an important role in preventing slip incidents. Establishing a 'sensible shoe' policy (for example, flat shoes that enclose the whole foot, not sandals or sling-back shoes) has been shown to make a significant impact on reducing slip and trip injuries. Ideally, such a policy should cover all staff, including cleaning and catering staff and pupils."*

In British Columbia, School District employers have not yet established a *uniform footwear policy*. School District safety personnel do offer advice in the selection of footwear. For that purpose, Safety personnel often utilize US and Canadian references that rate sole material against a defined walking surface.

Mekeel (2003) offers such a reference table:

Shoe Sole Material	***Tile (Dry)*** ***(Dry)***	***Tile (Wet) (Wet)***	***Wood (Dry)***	***Wood (Wet)***	***Concrete (Dry)***	***Concrete (Wet)***
Neoprene	*R*	*R*	*R*	*R*	*R*	*R*
Crepe	*NR*	*NR*	*NR*	*NR*	*R*	*R*
Leather	*R*	*R*	*R*	*R*	*NR*	*R*
Soft rubber	*R*	*NR*	*R*	*NR*	*R*	*NR*
Hard rubber	*NR*	*NR*	*NR*	*R*	*NR*	*R*

Note: 'R' means recommended/'NR' means not recommended

The Canadian Centre for Occupational Health and Safety (PPE - Safety Footwear, 1999) offers a different type of reference table. Aside for the column headed "*slipping*", the table addresses more "*resistance to absorption*" and/or "*resistance to damage*".

Sole Material	Abrasion	Chemical	Cement	Slipping	Water	Oil
Vibram	X	G	X	X	X	G
Leather	F	F	G	G	P	F
Neoprene	X	X	X	G	X	X
Neo Crepe	G	F	G	X	G	G
Rubber (vulcanized)	X	G	X	G	X	G
Nitrile	X	X	X	X	X	X
Polyurethane	X	X	X	G	X	X

X - excellent G - good F - fair P - not recommended

The Panel member from the Greater Victoria School District indicated that there have been custodial slips and falls during floor stripping operations. The Panel member found that custodians were walking on the still wet floors (and, were falling).

To reduce the likelihood of such slips and falls, the School District obtained special non-slip shoes and enforced their use.

Janitors' Warehouse representative, Mr. Nicholas, brought several examples of these non-slip shoes to a Panel meeting. The samples included strap-on and over-shoe type protectors. The sole material varied in composition from a strap-on "*Brillo-pad*"-type material to a specially-ribbed synthetic overshoe product.

Recommendation - A Written Floor Maintenance Program:

Define a written floor maintenance program that will ensure floors are kept clean; kept free of debris; kept free of standing water, oil or other liquid; and, kept free of other potential tripping hazards. Train workers in the application of the program. Supervise for adherence to the program. Keep records of the supervisory efforts.

Why?

English (1995) indicates (underlining added), "*The factors affecting traction between the shoe and the floor are (1) floor material and finish, (2) shoe bottom material and condition, (3) environmental contaminants present and (4) gait. The only factors under the control of the building owner are typically floor material and finish."*

There is a requirement in law to protect persons working on or visiting an employer's premise. In respect to employees, the requirement is contained in the BC ***Workers' Compensation Act*** and the associated ***Occupational Health and Safety Regulation***. An employer who fails to meet their obligation as stipulated by the WCB can be fined and/or prosecuted. An employer cannot be sued by a worker, however, members of the public can sue.

In respect to non-employees, an owner also has legal obligations. An issue of concern to an owner/operator would be liability. In general terms, liability may be defined as:

> ***LIABILITY*** *(In slip/fall accident cases)*
> *It is incumbent upon the owners of the premises upon which persons come by invitations, express or implied, to maintain such premises in a reasonably safe condition for the contemplated uses thereon and the purposes for which the invitation was extended.* (Gregory, 1981)

Another issue of concern to an owner/operator in respect to non-employees would be an accusation of negligence following a slip/fall incident. An accusation of negligence would have the following considerations:

> ***NEGLIGENCE***
> *Negligence is the failure to exercise ordinary care under the circumstances - the care that would be exercised by a reasonably prudent man…The floor needs to be safe for ordinary walking: it does not need to be so safe that an accident could not possibly happen…The owner must exercise reasonable diligence to insure that the floor is swept, dusted, and damp mopped as needed to keep the floor free from items that can temporarily render the floor slippery, such as debris, water and spills.* (Gordon, 1981)

Although manufacturers like Buckeye International (Bulletin No. 1496, 1996) "…*will supply an expert witness in the defense of a slip and fall case. Buckeye will provide technical assistance to defense attorneys in preparation for the case.",* it is better to design a program so as not to have to go to Court in the first place.

A written, defined and monitored program prepares for a defense of due diligence.

Due diligence is the only defense that the WCB will consider should penalty or prosecution seem warranted.

At the heart of any due diligence defense is the "*reasonable man*" test. Was everything done that a reasonable person would have (should have) done to prevent an occurrence. If so, it will be difficult to invoke a WCB penalty or be successful in a lawsuit.

If not, and should serious injury result, Bill C45 which came into effect in March 2004 (Federal legislation) changed the Criminal Code of Canada. Under Bill C45, persons who are deemed to be negligent can be fined or imprisoned. School District Heads should consider how their programs would look from a defense perspective in a prosecution case.

The Vancouver School Board Panel members reinforced the value of autoscrubbers. The VSB Panel members indicated that autoscrubbers provide cleaning consistency and, as they use clean water (and, extract the dirty water), they leave less contamination behind. The Greater Victoria School District member affirmed the VSB members' position and indicated that autoscrubber reduce the exposure risk (as they permit faster turnaround time when cleaning).

Recommendation - Choose a Suitable Flooring Material:

Choose a suitable flooring material - one that has the best chance of maintaining its integrity and its coefficient of friction under conditions of normal use and maintenance. Record the rationale behind the selection. Preserve the written record. Ensure the floor surface is maintained.

Why?

English (1995) indicates (underlining added), "*The factors affecting traction between the shoe and the floor are (1) floor material and finish, (2) shoe bottom material and condition, (3) environmental contaminants present and (4) gait. The only factors under the control of the building owner are typically floor material and finish."*

In choosing a floor material, it is necessary to consider the environmental condition under which the floor must function. If the floor material slip-resistance would suffer due to environmental factors and, if the floor material were to be installed knowing that an unsafe condition would be realized, the stage would be set for a negligence accusation.

Similarly, if the floor material was permitted to deteriorate to an unsafe point or, if the floor slip-resistance were to be knowingly reduced as a result of the selection of an improper coating material, an accusation of negligence might also be made.

Recommendation - Choose a Suitable Floor Treatment:

Choose a floor finish that is compatible with the floor material. Choose a floor finish that, when applied in accordance to manufacturer's directions, will provide a coefficient of friction in excess of 0.50. Choose a floor finish that will maintain the coefficient of friction in excess of 0.50 when it is wet or dirty and as the surface wears. Apply the finish in accordance with the manufacturer's instructions. Do not apply products from different manufacturers on the same area (unless the directions specifically allow for such an application). Keep written records of the materials applied; the date of application; and, the after-application treatment administered.

Why?

English (1995) indicates (underlining added), "*The factors affecting traction between the shoe and the floor are (1) floor material and finish, (2) shoe bottom material and condition, (3) environmental contaminants present and (4) gait. The only factors under the control of the building owner are typically floor material and finish."*

Buckeye International (Bulletin Number 703, 2002) as a manufacturer/supplier of floor finishes indicates that "*The purchaser presumes the safety of a floor finish, just as he presumes the finish will have adequate film formation and water resistance…it is, and should always be, an assumed property of floor finishes intended for pedestrian walkways."*

Buckeye International (Bulletin Number 798, 1998) states - as do all other manufacturers - that "*Buckeye contracts with Underwriters Laboratories Inc. to test the slip resistance of all our film forming floor care products…normal maintenance practices will not affect this property."*

So, if the owner/operator chooses a suitable floor finish, applies it correctly and maintains it satisfactorily, the likelihood of a slip/fall incident will be significantly reduced.

Recommendation - Purchase a Slip-test Meter:

Purchase a slip meter (tribometer). Standardize on a slip meter that will allow for exchange of measurements with adjoining School Districts. Standardize on a measurement technique compatible with other School Districts. Monitor the after-application wear history of flooring regularly and record the results. Use the tribometer readings as a tool to establish re-treatment intervals based upon coefficient of friction readings. Build a data base on flooring performance over time and floor treatment performance over time. Exchange slip meter measurement information and floor treatment performance with other School Districts. Use the tribometer as part of the incident investigation process (to assess "slipperiness").

Why?

Slips and falls happen when floor finish erodes and when the floor is not kept clean. School Districts allocate considerable resources to prevent erosion and to ensure cleanliness. Many School Districts indicate that they continue to research floor finish products with the goal is to extend floor finish life.

School Districts maintenance groups function in isolation. If one District identifies a superior product (or, an inferior one), there is no defined mechanism to announce the find. There is also nothing other than anecdotal information available to convince another District of the merits of the discovery.

The *Safety Engineer* (2004) lists examples of available slip-resistance testing devices, their approximate cost and a potential contact point for information.

Type of Testing Device	Cost (US $)	Information Available Through:
Technical Products Model 80	1,000	voicesofsafety.com
Brungraber Mark I	6,000	Slip Test Inc, NJ, USA
Brugraber Mark II	4,000	Slip Test Inc, NJ, USA
James Machine	18,000	Quadra, Wi, USA
Tortus II	-	Mission Instruments, Ca, USA
Horizontal Drag Slipmeter	-	Mission Instruments, Ca, USA
Sellnaier	-	Pioneer Eclipse, NC, USA
HPS	2,000	www.trusty-step.com
The Kett	2,900	www.kett.com
Pendulum Tester	-	Mission Instruments, Ca, USA
Satra Tester	-	www.fddiindia.com
D.F. Tester	-	www.frictionmeasure.com

Di Pilla (2004) offers the following table to assist in the selection of the correct type of tribometer.

American Society for Testing Materials (ASTM)

ASTM #	Method Name	Lab Use	Field Use	Dry	Wet
F489	Standard Test Method for Using a James Machine	R	N	R	N
F609	Standard Method for Using a Horizontal Pull Slip meter (HPS) Slipmeter	-	R	R	N
F1678	Standard Test Method for Using a Portable Articulated Strut Slip Tester (Brungraber Mark I)	-	R	R	N
F1677	Standard Test Method or Using a Portable Inclinable Articulated Strut Slip Tester (PIAST) (Brungraber Mark II)	-	R	R	R
F1979	Standard Test Method for Using a Variable Incidence Tribometer (VIT)	-	R	R	R

"R" denotes "recommended *"N" denotes "not recommended"*

If School Districts could agree on a common slip-test device and, if Districts would commit to using the device to evaluate the performance of floor materials and floor treatment products, Districts with the same environmental challenges would be able to select products with a proven performance history. Products that had failed to realize their potential in one District would be flagged and another District considering the use would be forewarned.

Miller (n.d) offers an advantage to testing, "*On those rare situations where the contaminant is a failed product and is not visible, routine testing of floor conditions with an inexpensive slip meter is useful. It is useful primarily as an aid to intuition and plays only a small part in a systematic program…The trick is to isolate the contaminants and remove them, not to measure them. Your most important asset is your employee, not your slip meter.*

Recommendation - Buy and Use NFSI Certified Materials:

Adopt the practice of using product that has been rated as "high traction" by NFSI (USA) and which carries the NFSI certification label.

Why?

Kenzidor (2003) identifies an initiative being promoted in the United States. According to Kenzidor, the National Floor Safety Institute (NFSI) has developed a new standard for product safety. Manufacturers submit their product for two-phase testing.

- Phase 1: Product tested with the NFSI Universal Walkway Tester (UWT) for its wet slip resistance. If it exceeds a SCOF value of 0.6 it is eligible for Phase 2 testing.
- Phase 2: Product placed in a '*real work*' situation for 30 days; product then cleaned as per manufacturer instructions; product is re-tested with the UWT. If the SCOF exceeds a value of 0.6, it may be classified as "*high traction*" and carry the NFSI certification label.

Goodwin (1999) explains the rationale for the NFSI initiative,

> "*Since it is impossible to get a tile cleaner than it was brand new, the tile's COF right out of the box can serve as a value of 100% clean. As the tile becomes dirty, its COF will naturally drop off due to the buildup of dirt and polymerized film…Since the COF of the tile is a known, cleaning methods and materials can be evaluated by seeing how close they can come to restoring the tile's original COF."*

If School Districts focus on NFSI certified products, the Districts can expect to have a "*safe*" floor (COF >0.5). The School District would use its slip-test meter to confirm the "*safe*" COF value immediately after product application (and, would record the value). The School District would then know what the "*clean coefficient of friction value*" is for the product, as applied.

The School District would then retest the floor at designated intervals.

As the COF value fell (as the floor became "*dirty*"), the School District would be able to define the point where the floor required cleaning (to restore the COF value before the floor became "*unsafe*", e.g., a COF <0.5). Over time, the testing record would allow for forecasting of defensible cleaning regimens.

Recommendation - Investigate All Slip/Fall Incidents

Conduct an investigation of every slip/fall that takes place in the School District whether time loss or not. Include tribometer readings as part of the incident investigation report (where the worker did not trip and fall over something or someone. Follow a defined incident investigation format. Build a data base from the recorded incidents in the School District. Be prepared to share the District data base information with other School Districts (and/or with BCSSA and BCPSEA researchers).

Why?

When the BCPSEA and the WCB agreed to cooperate in the production of this report, School Districts were contacted for information. School Districts could not produce historical records or, if they could, records were time-consuming to retrieve, were incomplete or were in radically different formats. It was difficult - in some cases impossible - to collect the data and compare it.

The WCB collects data on slips and falls in School Districts but only codes data on claims that incur wage loss. Medical aid claims are not coded. Wage loss claims are ordinarily a small subset of total claims. If School Districts do not collect data on the non- wage loss incidents, that data is lost to researchers.

The WCB does not collect data on non-workers. If a student slips and falls or, a visitor, there is no way to easily retrieve the pertinent information. Unless School Districts collect information about these non-worker incidents, the information will be lost to researchers.

The WCB does not know of incidents that stop with First Aid treatment (no wage loss or medical aid). Normally, there are many more non-compensable reports before there is a "*recognized*" incident. To be proactive and preventative, slip/fall First aid reports also need to be investigated and the results recorded.

Slips and falls contribute approximately 20% of the total WCB wage loss cases.

Recommendation - Use a Standard Investigation Form:

Miller (Measurement of Slip Resistance, n.d.) states: "*Where slip resistance is an important element in the investigation of accidents, it is only one variable*. "

School Districts need to standardize on an accident investigation model when addressing slip/fall situations. The model would include a standard form/format for acquiring data. Data collected could be accumulated and exchanged between Districts.

Why?

Gregory (1981) discusses the investigation of accidents in the United States where liability and lawsuit are more of an issue than they currently are in Canada. Gregory defines the general nature of information that would be collected in the US in preparation for defending against a "*negligence-type*" lawsuit.

According to Gregory, the information to provide includes:

- information on the product (exact name, manufacturer's name, date of purchase, results of coefficient of friction testing (by James Machine), sales volume)
- traffic test results run on site by the user
- accident information (time, date, place, description of the premises, witness statements, weather conditions, type of flooring (age and condition), appearance of the floor (e.g., state of repair), presence of debris or spills, presence of build-up, prior complaints about the site, lighting, handrails, inclines, transition areas)
- maintenance record (what polish was on the floor, when was the floor last stripped and recoated, when was the floor last mopped or dusted, how long does the floor finish last, what products have been used as mopping aids)
- type of footwear worn (new or old shoe, sole material and condition, heel material and condition, style of shoe (e.g., loafer, high-heels, flat sole), presence of debris in the sole tread)
- what was the individual doing at the time of the slip (walking, running, carrying a load)
- was the individual impaired in any way (vision problems, employs walking-assist)
- what was the individuals state-of-mind (i.e., not paying attention, distracted by something)

As follows, the Panel drafted a model incident investigation report for School District consideration.

SAMPLE SLIP/FALL INCIDENT REPORT

	Document No.	
School District Name:	School District #	
Site Address (Where slip/fall occurred:	Date of Slip/Fall:	

Date Report Generated:
Author of Slip/Fall Report (print name):
Job Title of Report Author:

Date of Slip/Fall Incident:
Time of Day Slip/Fall Occurred: _____ AM ☐ PM ☐
Weather Conditions (at the time):

Reason for Report:

Report only: ☐ First Aid Visit: ☐ Medical Aid Req'd: ☐

Severity of Injury:

Minor: ☐ Lost Time: ☐ Unknown: ☐

Part of Body Affected (one or more):

Head: ☐ Back: ☐ Shoulder(s): ☐

Neck: ☐ Arm(s): ☐ Leg(s): ☐

Ankle: ☐ Other: ☐ Specify: _____

Location of Slip/Fall:	Indoors: ☐	Outdoors: ☐

Entranceway: ☐ Hallway: ☐ Classroom: ☐

Office: ☐ Kitchen: ☐ Gymnasium: ☐

Shop: ☐ Parking Lot: ☐ Pathway: ☐

Other: ☐ Specify: _____

Type of Slip/Fall:

On the same surface: ☐ From one surface to another at a different height: ☐

From one surface to another at the same height (at a transition point): ☐

Over something on the floor: ☐

Number of Individuals Who Slipped/Fell:

One ☐ Two ☐ > Two ☐ Specify: _____

Gender of Individual Who Fell	Male: ☐	Female: ☐

Occupation of the Individual(s) Who Slipped/Fell:

Teacher: ☐ TA: ☐ Principal: ☐

Clerk: ☐ SD Wkr: ☐ Non- SD Worker ☐

Student: ☐ Visitor: ☐ Other: ☐

Type of Flooring Material:

Concrete: ☐ Wood: ☐ Ceramic Tile: ☐

Linoleum: ☐ Terrazzo: ☐ Rubber: ☐

Carpet: ☐ Other: ☐ Specify: _____

Condition of Flooring Material:

Intact (no damage): ☐ Damaged: ☐

Floor Coating Applied:

Yes: ☐ No: ☐

Condition of Flooring Material:

Good Condition: ☐ Badly Worn: ☐

Name of Floor Coating Material Applied:
Product Manufactured By:
Date Last Coating Applied:

Appearance of Floor:

Dry: ☐ Contaminated: ☐

Clean: ☐ Dirty: ☐

If Contaminated, with what:

Boulder Dust: ☐ Water: ☐ Oil: ☐

Sand: ☐ Debris: ☐ Other: ☐

Date of Last Cleaning:

Name of Cleaning Product Used:

Coefficient of Friction Measurement Taken:	Yes: ☐	No: ☐
If yes, actual COF value recorded:		
Slip-Meter Manufacturer Name/Model:		
Measurement Taken By (print name):		

Activity Underway at the Time of the Slip/Fall - Person was:

Walking: ☐ Running: ☐ Standing: ☐

Carrying Object ☐ Horseplay: ☐

Style of Footwear Being Worn:

Low Heel: ☐ High Heel: ☐ Runner: ☐

Other: ☐ Specify: _____

Sole Material:

Leather: ☐ Rubber: ☐ Neoprene: ☐

Plastic: ☐ Other: ☐ Specify: _____

Condition of Sole Material:

Good Condition: ☐ Slightly Worn: ☐

Badly Worn: ☐ Tread Clogged: ☐

Any Other Observations on the site:

_____

_____

_____

_____

Were There Witnesses to the Slip/Fall: Yes ☐ No ☐

If "Yes":

Witness Name (Print):	
Summary of Statement:	
Witness Statement Appended:	
Date of Witness Statement:	

Witness Name (Print):	
Summary of Statement:	
Witness Statement Appended:	
Date of Witness Statement:	

Signed: _____

(Incident Report Originator)

Recommendation - Conduct Education Sessions:

School Districts need to increase awareness of slip/fall hazards and means of reducing the likelihood of becoming involved in a slip/fall incident. School Districts should consider a campaign of education and instruction in School District facilities centered perhaps with site Health & Safety Committees. The campaign could include safety newsletters, safety posters, hazard alerts and publication of slip/fall reports (edited versions). Existing staff bulletin boards would be one vehicle for communication; another vehicle might be staff meetings and/or scheduled staff assemblies.

Why?

English (1995) notes that, "*People can walk safely on surfaces that are slipperier than ice, if they know of the hazard."*

Goodwin (1999) notes that "*People consciously or unconsciously alter their walking styles to account for the perceived slipperiness…"* And, Goodwin observes, "*…people often fall…because they have no opportunity to perceive the difference in slipperiness and have not changed their gait accordingly."*

When addressing the Panel, Dr, Siegmund from UBC spoke about a confounding effect in slip/fall research. Dr. Siegmund told the Panel that volunteers selected for study purposes sometimes did not fall although the coefficient of friction of the walking surface was zero. Dr. Siegmund explained that, if the research volunteer anticipated that the surface would be slippery, the volunteer would unconsciously take measures to avoid falling (by altering their gait). The Panel felt that, by making employees (and, visitors) more aware, School Districts should be able to harness this natural ability.

The BC School Safety Association (Preventing Slips in Schools, n.d.) published a paper entitled, "*On the Right Track: An Occupational Health & Safety Checklist Designated for Schools*" and a pamphlet entitled "*Tips to Eliminate Slips*". Panel members remembered both documents and were very positive about the result. Panel members, however, remembered the documents in the past tense; nothing current. A key to maintaining awareness is to keep the campaign current. Staff change. School Districts need to mount an on-going campaign of education and awareness to focus and maintain attention.

REFERENCES:

Angel, Tony. (1991). *Report on Floor Slip Accidents and Floor Finishes.* Unpublished data from Vancouver School Board, 1-11.

ANSI Standard addresses fatal injuries (Slips and Falls). (March 2002). *Occupational Hazards*, 1. Retrieved February 22, 2004, from http://www.findarticles.com/cf_dls/m4333/3_64/83916245/print.jhtml

ASTM D2047-82: Standard Test Method for Static Coefficient of Friction of Polish-Coated Floor Surfaces as Measured by the James Machine (1982). *American Society for Testing Materials*. 1-4.

Aussies Need 'Roadworthy' for Shoes. (2000, February). Press Release. *CSIRO Manufacturing & Infrastructure Technology*, 1-3. Retrieved April 18, 2004, from http://www.cmit.csiro.au/news/viewpress.cfm/53

Bowman, R. (1997, July). Resolving the Grey Area of Slip Resistance. *CSIRO Building, Construction and Engineering*, 1-7. Retrieved April 18, 2004 from http://www.cmit.csiro.au/vb2/345/50/index.htm

Bulletin Number 703: Selling Slip Safety. (2002). *Buckeye International Inc*, 1.

Bulletin Number 798: Properties That Affect Slip Resistance of Walkway Surfaces. (1998). *Buckeye International Inc*, 1 .

Bulletin Number 1397: Slip Resistance Measurement of Floors. (1997). *Buckeye International Inc*, 1.

Bulletin Number 1496: Services Provided by Buckeye International, Inc. in Defense of Slip and Fall Injury. (1996). *Buckeye International Inc*, 1.

Buckeye International. (1977). *Slip Resistance Testing*, 1-2. Retrieved March 1, 2004, from http://michco.com/HelpStuff/Slip_Resistance_body.html

Di Pilla, S. (2002, November). Get a Grip: Methods for Measuring Slip Resistance, *Sanitary Maintenance*, 1-4. Retrieved February 21,2004, from http://www.esis.com/whatsnew/asp

Di Pilla, S. (2004). Get A Grip: Methods for Measuring Slip Resistance. *ESIS What's New*, 1-4. Retrieved February 24, 2004, from http://www.esis.com/whatsnew.asp

Di Pilla, S., Vidal, K. (2001). Slip-Resistance Measurements: The Current State of the Art. *Engineering Practice Specialty Newsletter*, 1- 8.

Economical Slip Meters (2004). *Safety Engineer,* 1-4. Retrieved April 18, 2004, from http://www.safety-engineer.com/comingsoon.htm

English, William. (1995). Ten Myths Concerning Slip-Resistance Measurement. *Professional Safety*, 1-5. Retrieved March 1, 2004, from http://www.englishxl.com/myth.html

English, W. (2002, August). *What is a Safe Walking Surface*. 1-3. Retrieved April 18, 2004, from http://www.englishxl.com/aug13-02.html

English, W. (2003, April). *Should the Threshold of Safety Be .50?,* 1-5. Retrieved March 1, 2004, from http://www.englishxl.com/point5.html

Finishes for Wood Floors: A primer on the types of finishes used on wood floors. (1998). *The Old House Web*, 1-3. Retrieved April 7, 2004, from http://www.oldhouseweb.com/stories/Detailed/12214.shtml

Floor Problems - New Resilient Floors. (n.d.). *Janitors' Warehouse*, 1-2.

Floor Safety: Measuring Slip Resistance. (2002). CSPA Polishes and Floor Maintenance Division. *Trade Journal for Industry Review*, 2002, 1-4.

Flooring. (n.d.). *Janitors' Warehouse*, 1-5.

Gallagher, E.M. and Scott, V.J. (1995). *The Steps Project: A Project to Reduce Falls in Public Places Among Seniors and Persons with Disabilities*. University of Victoria School of Nursing, 1-56.

Goodwin, V. D (1999). Measuring Clean, 1-2. Retrieved February 22, 2004, from http://www.nfsi.org/pdfs/slip_article.pdf

Goodwin, V. D. (1999, March). Slip and Fall Accidents - Floor Testing, 1-6. Retrieved March 1, 2004, from http://www.mde.com/publications/slipfall.pdf

Gregory, Gordon K. (1981). *R&D Involvement in the Defense of Slip/Fall Accident Complaints*. Paper presented at the CSMA 67th Mid-Year Meeting, 240-243.

Hermele, Jules. (1999, January). *An Introduction to Anti-Slip Coatings, Coatings and Linings,* 1-4. Retrieved February 24, 2004, from http://www.astanislip.com/commercial/new_pages/company.html

Heuston, Fred. (n.d.). What is Coefficient of Friction? *Marble Institute of America*, 1-5. Retrieved February 24, 2004 from http://www.marble-institute.com/SlipResistant.asp

How to Care for Floor Pads, Mops and Buckets. (n.d.). *Janitors' Warehouse*, 1-2.

How to Finish (Wax) Floors. (n.d.). *Janitors' Warehouse*, 1-2.

How to Strip Floors. (n.d.). *Janitors' Warehouse*, 1-2.

The Inside Story: The Birth of a Floor Polish Film. (n.d.). *Advances.* Interpolymer Corporation, 1-7.

Kendzior, R. (1999). Slip-and-Fall Prevention Made Easy: A Comprehensive Guide to Preventing Accidents. *Government Institutes Made Easy Series*, 1-81.

Kendzior, R. (2003, July). Safety zone: Get traction in the slip-and-fall dilemma. *Cleaning & Maintenance Manager*, 1-4. Retrieved April 19, 2004, from http://www.cmmonline.com/article.asp?IndexID=6633788

Kendzior, Russ (2004, April). Slip & Fall: Who's got your back? *Cleaning & Maintenance Management*, 37-42.

Keyserling, W. M. (2000, July). Working Surfaces/Slips and Falls, *IOE 539 Notes*, 1-8. Retrieved April 14, 2004 from http://ioe.engin.umich.edu/ioe539/slips.pdf

Lemon, P. (n.d.). Pedestrian Slipping: Slopes and Encumbrance. *Executive Summary-HSE*, 1-2. Retrieved March 1, 2004, from http://www.hse.gov.uk/slips/research/slopes.htm

Market Analysis: Slip-Fall Accidents (2004, February). *Wonder Step.* 1-2. Retrieved April 17, 2004, from http://www.wonderstep.com/marketanalysis.htm

McFadden, Roger. (1993). What's In a Floor Finish. *Cleaning Management*, 26-30.

Mekeel, D. (2003, June), Slip, trip and fall prevention in schools: Reducing workers' compensation and general liability claims costs. *Safety Sense.* Pennsylvania School Board Association Insurance Trust, 1-3. Retrieved February 22, 2004, from http://www.psbait.org/Newsletters/SafetySense/inss0603.html

Meserlian, D. C. (1999, August). The Good & Bad Impact of ASTM Standards. *Voices of Safety International*, 1-7. Retrieved April 18, 2004, from http://www.voicesofsafety.com/t1-sf-astm-paper.htm

Miller, Barrett (n.d.). Slip Meters: How Much Do You Need. *Occupational Health & Safety*, 1-3. Retrieved April 18, 2004, from http://www.safety-engineer.com/slipmeters.htm

Miller, B. (n.d.). *Measurement of Slip Resistance, a legal and practical perspective,* 1-11. Retrieved March 1, 2004, from http://www.safety-engineer.com/surfaces.htm

Murphy, T. & Lussmyer, B. (2003, September). Selecting and maintaining textured floors. *Plant Services*, 1-5. Retrieved April 28, 2004, from http://www.plantservices.com/web_first/ps.nsf

Owen, D. (2002, May). Measuring Surface Traction and Engineering for Slip-Resistance. *APF Technical Bulletin*, 1-4. Retrieved March 1, 2004, from http://www.apfepox.com/includes/APFslipresistance.pdf

Owens, J.M. (n.d.) *The Physical Processes of High Speed Burnishing*. Rohm & Haas, 1-11.

PPE - Safety Footwear (1999). Canadian Centre for Occupational Health and Safety, *Safety Infogram*, 1.

Preventing slips and falls through effective floor care, Loss Control Tips: Technical Information Paper Series. (2002). *The Hartford Group*, 1-10. Retrieved April 1, 2004, from http://www.mb.the Hartford.com/insurance_info/pdfs/560-050.pdf

Preventing Slips in Schools. (n.d). British Columbia School Safety Association, 1-4.

Preventing slip and trip incidents in the education sector. (2003, March). *HSE Education Information Sheet No. 2*, 1-6. Retrieved March 1, 2004, from http://www.hse.gov.uk/pubns/edis2.pdf

Risk prevention: Assessment of "slipperiness" of floor coverings. (2001, January). , *CSTB Information Letter*, 1-2. Retrieved April 14, 2004, from http://www.cstb.fr/lettres_rech/Tletter01.htm

Sacher, Alex. (1993, August). Slip Resistance and the James Machine 0.5 Static Coefficient of Friction Sine Qua Non, *Standardization News*, 52-58.

Slips & Falls 2002-2003. (n.d.). Unpublished data from School District No. 60, 1-2.

Slip/Trip and Fall Survey 2002-2003. (June, 2003). Unpublished data from School District #68 (Nanaimo-Ladysmith), 1-2.

Slips and trips in the health services. (1996), *Health Services Sheet No 2*. HSE, 1-8. Retrieved March 1, 2004, from http://www.hse.gov.uk/pubns/hsis2.pdf

Slips and trips: Summary guidance for the catering industry. (1996). Health & Safety Education. *Catering Information Sheet No 6*, 1-4. Retrieved March 1, 2004, from http://www.hse.gov.uk/pubns/caterdex.htm

Slip resistance of pedestrian surfaces Part 1: Requirements. (1993). Australian/New Zealand Standards 3661.1:1993, 3-16.

Slip resistance of pedestrian surfaces Part 2: Guide to the reduction of slip hazards. (1994). Australian/New Zealand Standards 3661.2:1994, 3-9.

Slip Stop: Stop Accidents Before They Happen. *Slipstop International*, 1-22.

Summary of 7 WCB Reports 2002-2003. (June, 2004). Unpublished data from School District #57, 1-16.

Test Method for the Evaluation of Floor Polishes. (May, 1990). Rohm & Haas Company. 1-11.

Topaka Scientific Safety (1984). The Topaka Floor Slip Tester, 1. [Advertisement]. Williams Scientific Co.

Trips/Slips/Falls Accidents July 1, 2002 - June 6, 2003. (June, 2003). Unpublished data from School District 70 (Alberni), 1.

Turner, Lisa (2000). Understanding the Coefficient of Friction. 1-2. Retrieved February 24, 2004, from http://www.northstarcsi.com/techspecs/div09-0010coef-friction.htm

Workers Compensation Board of BC. (1998). *Annual Report - Statistics*

Workers Compensation Board of BC. (1999). *Annual Report - Statistics*

Workers Compensation Board of BC. (2000). *Annual Report - Statistics*

Workers Compensation Board of BC. (2001). *Annual Report - Statistics*

Workers Compensation Board of BC. (2002). *Annual Report - Statistics*

Bibliography

BC Public School Employers Association. (2004, March). *Resources & Services Manual*.

Coefficient of Friction for Concrete Floors. (2004, February). *Concrete Construction*, 1-2. Retrieved April 14, 2004, from http://concrete.org.uk/arc-forum.asp?

English, W. (1996). Pedestrian Slip Resistance: How to Measure It and How to Improve It. *Practical Tribometry for Safety Engineers*, 1-2. Retrieved March 1, 2004, from http://www.englishxl.com/cont.htm

Fact Sheet #705. (2003). *Buckeye International Inc,* 1-3.

How to Scrub Floors. (n.d.). *Janitors' Warehouse*, 1-2.

How to Seal Floors. (n.d.). *Janitors' Warehouse*, 1-2.

Physical Test Method PM144: Friction (Slip Resistance) of Footwear and Floorings (1999). *SATRA Technology Centre*, 6-11. Retrieved April 1, 2004, from http://www.satra.co.uk.index

Powers, C. M., Kulig, K., Flynn, J. & Brault, J.R. (n.d.). Repeatability and Bias of Two Walkway Safety Tribometers. *Slip/Trip & Fall - Publications,* 1. Retrieved March 1, 2004, from http://www.j2eng.com/SlipFall/Publications.htm

Product Guide: A quick reference to key information. (2000). *Fuller Brush Commercial Products*, Great Bend, KS, 1-7

Resources & Services Manual. (n.d.). BC Public School Employers Association.

Slip and Fall Evaluation. (2004). *ESIS: What's New*, 1-2. Retrieved March 1, 2004, from http://www.esis.com/news092000.asp

Walking & Working Surfaces: A Health and Safety Guideline for Your Workplace. (2002, August). *IAPA*, 1-3. Retrieved March 1, 2004, from http://www.worksafesask.ca/files/ont_iapa/walkingsurfaces.html