Slip trip and fall (STF) prevention
A scientific approach

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Objectives

- This presentation is designed to provide:
  - An understanding of the importance of STF assessments
  - An overview on how to utilize the Zurich 10-point STF assessment program
  - Insight on the major risk factors that cause or contribute to STF accidents
  - An understanding of the value tribometry provides to the STF assessment process

Why perform a STF assessment?

- STF is one of the leading causes of injuries for workers and third parties

  - Falls account for over 8 million hospital emergency room visits, representing the leading cause of visits (21.3%). Slips and falls account for over 1 million visits, or 12% of total falls. (Per year)
  - Average WC claim cost: $25,000 - $28,000
  - According to the Consumer Product Safety Commission (CPSC), floors and flooring materials contribute directly to more than 2 million fall injuries each year.
  - Half of all accidental deaths in the home are caused by a fall. Most fall injuries in the home happen at ground level, not from an elevation.

- Source: Centers for Disease Control and Prevention, National Center for Injury Prevention and control. Web-based Injury Statistics Query and Reporting System (WISQARS) [online]. Accessed November 1, 2010. http://webappa.cdc.gov/cgi-bin/broker.exe

Why perform a STF assessment?

- STF incident costs increasing
  - Soaring medical costs
  - Litigation/litigious markets
  - Fraud
  - Aging population/longer recovery times
  - Population 65+ to double next 20 years

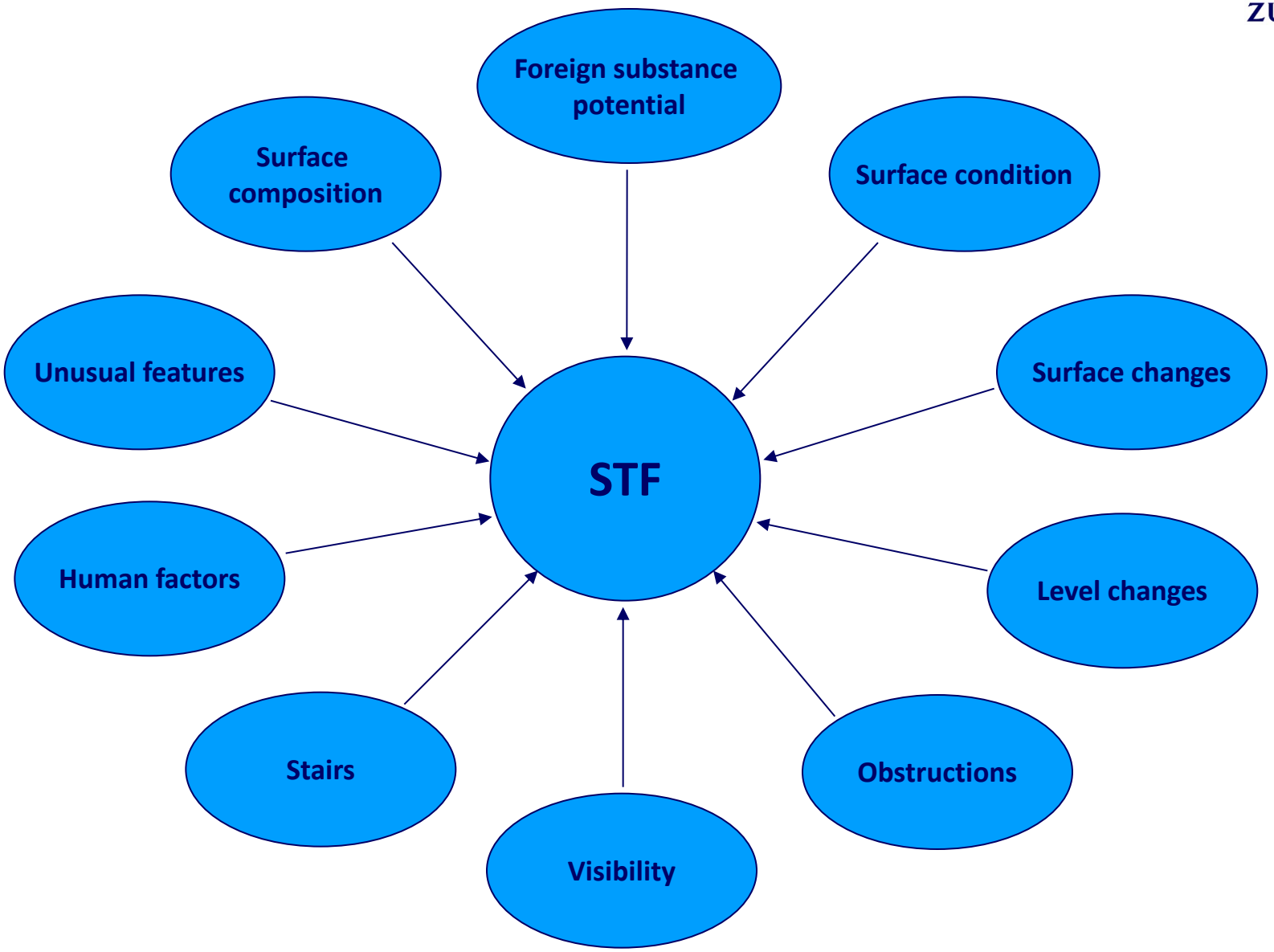
- Reducing STF claims adds significant dollars to the bottom line

- Source: CDC: U.S. senior-citizen population to double by 2030. USA Today.Com, Health and Behavior, February 3, 2003.

Zurich's 10-point STF Approach

- Developed using a forensic approach
- Convergence of the following 10 risk factors

- Surface composition
- Foreign substance potential
- Surface condition
- Surface changes
- Level changes
- Obstructions
- Visibility
- Stairs
- Human factors
- Unusual features



STF Risk Factor 1 – Surface composition

- Type of walking/working surface, interior or exterior
  - Vinyl composition tile (VCT), carpet, marble terrazzo, asphalt, cement, wood, etc.
- Suitability for use/environment

STF Risk Factor 1 – Surface composition

- Coefficient of friction - dry
- Slip resistance - wet
- Surface asperities or roughness enhance COF or slip resistance
- Most surfaces are safe when clean and dry
- Basic facts: Clean, smooth, hard surfaces are safe when dry, but very unsafe when wet. Similar slip resistance to ice
- ASTM F1637.10
  - Exterior walking surfaces shall be slip resistant
  - Interior walking surfaces that are not slip resistant shall be maintained dry
- **Don't forget about your own residence**

STF Risk Factor 1 – Surface composition

- Tribometry: Science of measuring slip resistance / shoe traction properties on walking /working surfaces, using a slip meter
- Slip meters must avoid sticktion in order to be used on wet surfaces
- Sticktion: Inability to test wet surfaces properly
  - Unit takes additional time to complete test stroke
  - Results in higher readings
- Must have properties similar to human ambulation
  - Horizontal and vertical/normal movement simultaneously
  - Similar to a human ankle

STF Risk Factor 2 – Foreign substance potential

- Likelihood of foreign substance
  - Water, oil, various contaminates, debris, etc.
  - Commonly referred to as lubricants
- Rate effect of foreign substance on surface being evaluated
- Spill controls
  - Cleanup measures (effectiveness)
  - Barricades and signage
- Tracking effect (under shoes)
  - Example: grease from a kitchen
  - Proper cleaning protocols ?
  - Avoiding polymerization?

STF Risk Factor 3 – Surface condition

- Maintenance
- Loose carpet
- Broken tile
- Pot holes

STF Risk Factor 4 – Surface changes

- Frequent changes in types of flooring
- High traction to low traction
- Low traction to high traction

STF Risk Factor 5 – Level changes

- Three or fewer steps
- Frequency of level changes
- Small and subtle changes
- Ramps
- Non-uniform steps

STF Risk Factor 6 – Obstructions

- Temporary
  - Electrical cords, pipes, hoses
  - Clutter, housekeeping
  - Tools, material, supplies
- Permanent
  - Parking wheel stops
  - Curbing/speed bumps

STF Risk Factor 7 – Visibility

- More than just illumination or lighting
- Consideration during an evaluation should include:
  - Glare and lack of color contrasts
- Poor visibility increases the adverse impact of surface/level changes and obstructions
- Business owners should draw attention to level changes by:
  - Using color contrasts
  - Marking step or stair nosings
  - Use of reflective or contrasting colors
  - Marker lights or spot lighting
  - Use of signage
    - "Watch your step"
    - "Please use handrail"

STF Risk Factor 8 – Stairs

- More than 3 steps
- Frequency and type of use
- Uneven stair geometry-3/16” to 3/8”
  - Runner 9 to10” existing, 11”new
  - Risers-8”existing, 7” new
  - Landings
  - Treads-slip resistant
  - Slope angle-30 to 35 degrees
- High risk stairs
  - Non-uniform steps
  - Worn or loose nosing, coverings
  - Wide with no reachable/graspable railing
- Handrails – shape-too big to grasp?

STF Risk Factor 8 – Stairs

- When not operating, escalator steps do not generally meet the standard step geometry for stairs.
- Businesses with escalators should have additional controls in place

STF Risk Factor 8 – Stairs

- Elevator carriages should be level with the floor at all floor stops to prevent tripping incidents.
- Elevator carriage floors and door thresholds should be slip resistant.
- Changes in floor surfaces from each floor to elevator should be clearly visible.

STF Risk Factor 9 - Human Factors

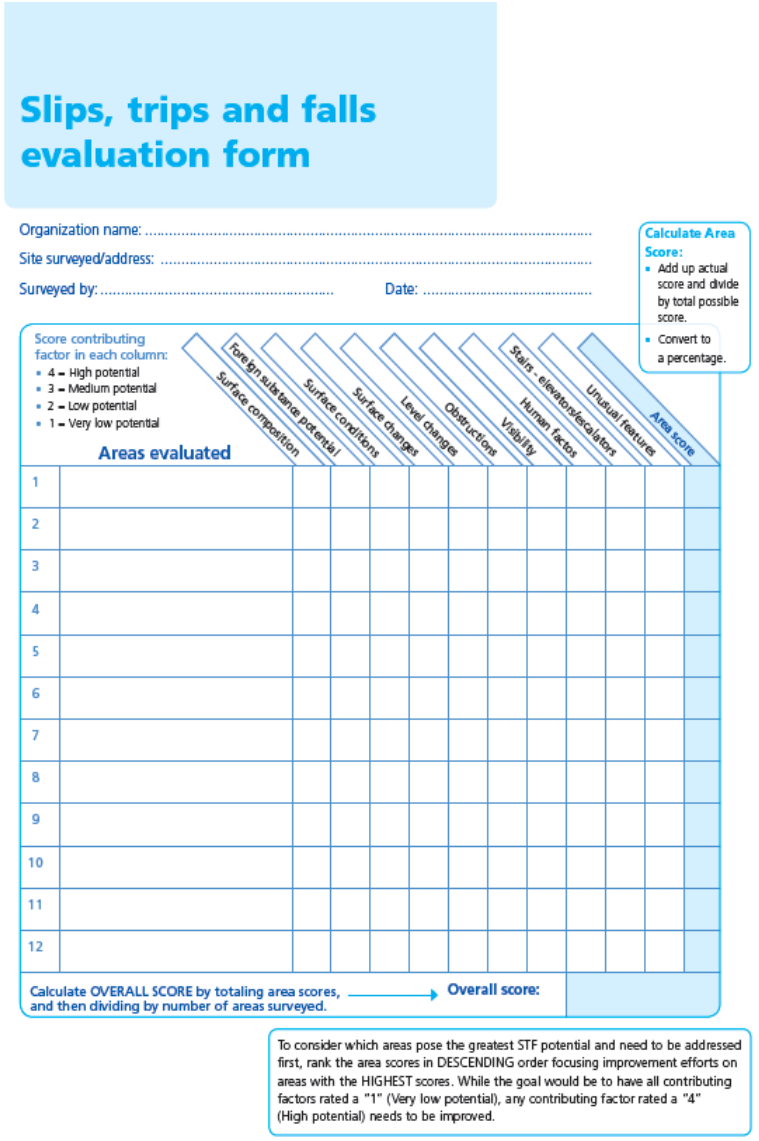
- Age
- Shoes
- Vision
- Physical, mental state
- Cumbersome objects/packages

STF Risk Factor 10 – Unusual features

- Distractions
  - Alarms/buzzers
  - Strobe/flashing lights
  - Heavy pedestrian traffic
  - Signs and attractive displays
  - Decorations
  - Strobe lights
  - Sales displays
  - Art work

Using the evaluation guide

- Fill out required information at top of slips, trips and falls evaluation form
- Identify areas you will be evaluating; list in left column
- Assess each area in relation to each contributing factor; If factor not present, do not score; Leave blank
  - Be honest in your evaluation
  - Take photos of areas evaluated and areas of concern. Barricade or place warning signs in areas identified with significant defects that need immediate action



Slips, trips and falls evaluation form

Organization name: .....

Site surveyed/address: .....

Surveyed by: ..... Date: .....

Calculate Area Score:
- Add up actual score and divide by total possible score.
- Convert to a percentage.

Score contributing factor in each column:
- 4 = High potential
- 3 = Medium potential
- 2 = Low potential
- 1 = Very low potential

Areas evaluated	Surface composition	Foreign substance potential	Surface conditions	Surface changes	Level changes	Obstructions	Visibility	Human factor	Stairs - elevators/escalators	Unusual features	Area score
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											

Calculate OVERALL SCORE by totaling area scores, and then dividing by number of areas surveyed. → **Overall score:**

To consider which areas pose the greatest STF potential and need to be addressed first, rank the area scores in DESCENDING order focusing improvement efforts on areas with the HIGHEST scores. While the goal would be to have all contributing factors rated a "1" (Very low potential), any contributing factor rated a "4" (High potential) needs to be improved.

Using the evaluation guide

- Score each contributing factor based on the potential exposure(s) present that could contribute to a slip, trip and fall
  - High potential = “4”
  - Moderate potential = “3”
  - Low potential = “2”
  - Very low potential = “1”

Using the evaluation guide

- Total scores for each area evaluated
- Use results to determine action plan and corrective measures
- Possible controls include:
  - Physical changes
  - Administrative changes

Physical changes

- Examples include:
  - Repair deficiencies in floor surfaces and railings
  - Replace slippery when wet surfaces with surfaces having adequate asperities or roughness
  - Test topical floor coatings that add asperities or consider etching to enhance slip resistance
  - Install grab bars and rails where appropriate
  - Avoid furnishings or decorations that might slip when leaned upon
  - Use color contrasts to make steps or other level changes more visible
  - Improve lighting

Administrative changes

- Administrative changes could include the following items:
  - Development of a written self inspection program
  - Complete staff slip, trip and fall prevention awareness training
  - Complete walking/working surface risk assessment to determine coefficient of friction / slip resistance of current surfaces
  - Test potential walking surfaces prior to purchase
  - Train decision makers on slip resistance basics

Administrative changes (continued)

- Ensure managers, supervisors and employees are aware of their responsibility for fall prevention.
- Identify visitors or employees who might be a high risk for falls due to lack of knowledge, unfamiliarity with the area, or physical limitations.
- Cover fall prevention topics with employees during employment training and weekly/monthly meetings.
- Include fall prevention items on routine self-inspection forms.
- Ensure corrective action is assigned to a responsible person for correction and follow-up is conducted by management.

Tribometry

Who Falls

- The At-Risk Population
  - Ambulatory deficits (Gait dynamics)
  - Physiologically &/or Neurologically impaired
  - Demanding tasks (loaded, turning, velocity)
  - Perceptive deficits (inherent or induced through distraction)
- Physical fitness reduces the potential for and impact of a STF
  - Recovery (muscles over power mass)
  - Wellness

Phases of Human Ambulation – (Walking)

- The Gait Cycle:
  - Push Off – highest traction requirement
  - Swing Phase
    - interruption results in trip
    - ¼” max vertical change in elevation
    - Swing leg is traveling 2X the walking speed
  - Heel contact
    - Reduces swing leg speed to zero
    - Initial contact approximately 30 degrees
    - Constant smooth application of force after

Defining the Hazard

Slips & Slip Resistance

- Slips: result from inadequate friction on the shoe/floor interface
  - Remember surface asperities
  - Water – the most common contaminant
  - Hydrodynamic squeeze film, build up of contaminant between surface and shoe "hydroplaning", where foot is momentarily supported by the film not the surface.
    - Slip resistance of the surface become irrelevant
    - Some surfaces disperse water better than others
  - Traction demand based on the need of the person and activity

- Slide Recovery (Near Miss)
  - Requires neurological and physiological response for recovery
  - Creep-arrest on the English XL Meter

- The most effective means of reducing S&F's: make floor slip resistant
  - Surface roughness dictates slip resistance: 'almost', it's the sharpness of the asperities

Engineering Principles

Methodologies related to walkway and footwear safety

1. Floor surfaces* (XL quantify slip resistance, before & after)
   - Smooth, shiny, hard surfaces vs. carpet
   - Floor surface treatments (epoxy, etching, mats, metals)

2. Contaminant on floors* (XL quantify effectiveness of housekeeping)
   - Water – the leading cause of slips
   - Chemicals/debris & housekeeping

3. Footwear*
   - Slip resistant shoes (Shoes for Crews)
   - Shoe program (Evaluations/reimbursement)
   - Special exposures (Snow/Ice)

4. Gait dynamics (not controllable)

***Controllable**

Required Slip Resistance

- .25 to .35 min amount of traction required to for straight line unloaded walking at normal speed. Peak is at toe-off
- .5 is a margin of safety, most people can walk on surfaces with slip index of < than .3 (thus it's not the overall traction of the floor)
- It's usually a localized spot slipperier than other areas that causes the slip
- STF Trivia: What is the slip resistance of ice?

Standards for Testing

Wet & Dry Testing (all withdrawn, available for sale)

- ASTM F1677, Brungraber MK II (PIAST)
- ASTM F1679, English XL (VIT)
- ANSI A1264.2, “Provision of Slip Resistance in the Workplace”

Dry Testing

- ASTM609, HPS
- ASTM C1028, HPD (Horizontal Pull Dynamometer with 50 lb)
- ASTM D2047, James Machine (test floor polishes)
- UL 410, UL std for rating materials, James Machine

Other Standards

- ANSI A1264.2-2 2001 “Std for the Provision of Slip Resistance on Walking/Working Surfaces
- ASTM F1637-02, “Standard Practice for Safe Walking Surfaces”
- ANSI A117, “Accessibility of Facilities to the Handicapped”
- NFPA 1901, “Standard for Automotive Apparatus”

- ASTM F2508, "Standard Practice for Validation and Calibration of Walkway Tribometers Using Reference Surfaces". The F2508 Standard Practice establishes a methodology to assure the precision and repeatability of walkway tribometers.

When to Utilize Tribometry

- Design phase
- Identify the slip resistance for problem areas
- Quantify the effectiveness of cleaning efforts
- Quantify the improvement in slip resistance for floor surface modifications
- Claims/investigative process

Friction and Adhesion

- Friction is the resistance to motion along the surfaces of two objects in contact with one another

- Adhesion is when one material sticks to another
  - Mechanical (velcro)
  - Dispersive (Van Der Waals)
  - Diffusive (polymerization)

- Traction comes from friction and friction from adhesion. Asperities play a key role in this process and can be counteracted by contaminants.

Available Slip Resistance

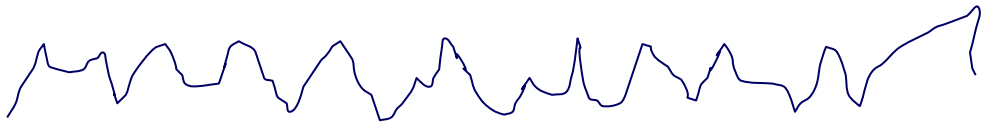
- Walkway Surface Texture
  - Abrasive
  - Embossed
  - Carpet

- Asperities
  - Sharpness and Roughness
  - Height & Frequency
  - Must take contaminant depth into consideration
  - Affected by:
    - Cleaning, Wear, Installation practices

- Smooth, hard shiny surfaces are dangerous when wet. The reflection is a tell tale sign of a slippery surface!

Asperity Types

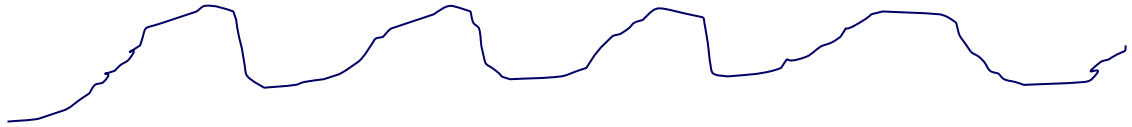
- Sharp and prominent



- Smoothed

- Etched

- Worn



STF Resources

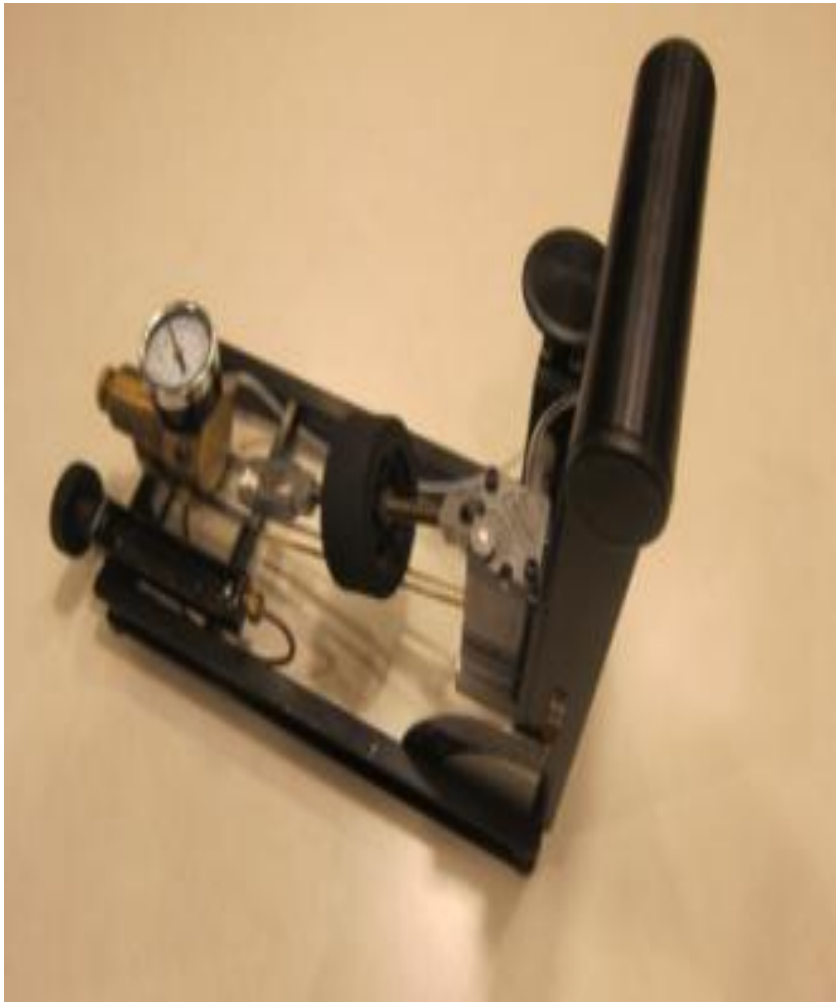
- Zurich's 10 Point STF Program (Not the only carrier or consultants with this capability)
- Excel Tribometers – Excellent resource for training and the XL Tribometer
- Pedestrian Slip Resistance – How to Measure It and How to Improve it by William English
- Slip, Trip, and Fall Prevention – A Practical Handbook – Steven Di Pilla
- NFSI/ANSI B101.1-2009 "Test Method for Measuring Wet SCOF of Common Hard-Surface Floor Materials"

Conclusion

- Preventing slip, trip and fall incidents requires a multi-faceted approach.
- Use the knowledge you gained today to advance your organization's approach.
- Ensure defects are identified and corrected as soon as possible.
- If you are uncertain as to the slip resistance that is provided with your current walking/working surfaces, have them evaluated by a Zurich professional.
- Undergoing a remodel or starting a new construction project, consider installing safer walking and working surfaces.

English XL Variable Incidence Tribometer (VIT)

English XL Tribometer



English XL Tribometer

English XL Tribometer

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