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.

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

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/flashlighting 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
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
    - $\frac{1}{4}''$ 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
Engineers 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”

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

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

- Handle & Strut
- Pressure Gauge & Regulator
English XL Tribometer
English XL Tribometer
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