Slip Resistance Guide

Safety, protective and occupational footwear supplied into the European market

SATRA TECHNOLOGY

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INTRODUCTION

"Improve the Product – Reduce the Risks"

The aim of this booklet is to give a concise overview of slip resistance in relation to safety, protective and occupational footwear supplied into the European market. In particular, it aims to help product developers and buyers to better understand the legal and practised requirements.

International test methods and standards for assessing slip resistance of footwear are available and must be met. However, slip resistance is a complex property with many factors to consider. An understanding of both footwear and flooring factors is important, and a risk assessment should be carried out (see p12).

Realistically, the aim is to:
- Reduce the risk of accident and injury to people
- Reduce liability and claims on manufacturers and suppliers.

Fit for Purpose

When considering footwear, the product has to be fit-for-purpose, which also means that it should provide a reasonable and appropriate degree of safety. Legislation and regulations help to define what this means. Where there are specific hazards to be managed, it may mean providing slip resistance safety floors and/or slip-resistant protective footwear.

CE-Marked safety, protective or occupational footwear may be issued to employees – especially in the EU. Appropriate footwear selection can significantly minimise the risk of slip accidents and consequent injuries, but will not eliminate them.

WORKPLACE SLIP ACCIDENT STATISTICS

Slips and trips are the most common cause of major injuries at work and can happen almost anywhere – 95% of major slips result in broken bones and they can also be the intial cause for a range of other types of accident, such as a fall from height.

Similar rates of workplace slip accidents are reported in Europe, USA and Australia.

Significant numbers of slip accidents also occur in the home and during sports and recreation.

Litigation and insurance claims for slip accidents are on the increase in all areas.

FOOTWEAR versus FLOORINGS

The first point of contention when investigating a slip accident is often the identification of the real cause of the accident: is the footwear or flooring at fault? In reality, the answer is rarely 'black and white', as there can be many contributory factors.

Clean, dry floors are rarely a cause of concern. The majority of slip accidents occur on wet or contaminated surfaces. Therefore, housekeeping is often a major factor, along with the type and surface roughness of the underfoot flooring.

Footwear alone will not eliminate slip on contaminated surfaces and, indeed, some footwear may be slippery on smooth dry surfaces. It is impossible to make footwear 'non-slip' or resistant to slip under all conditions which may be encountered in wear. Careful selection of footwear that meets basic tread pattern design guidelines and surpasses minimum friction guideline levels, however, will help to minimise the risk of slipping accidents.

LEGISLATIVE REQUIREMENTS FOR INDUSTRIAL FOOTWEAR

UK Health & Safety legislation places duties on employers, owners and landlords to prevent or control slip risks. Where unsuitable footwear is considered to be a factor in a slip risk assessment, then the employer has a duty to provide, free of charge, special protective footwear. This footwear has to be appropriate for type of floor, task, fit and also needs to be maintained or renewed as necessary.

Thus, if there is a specific risk of slip in the workplace which good slip-resistant footwear could help to reduce, suitable footwear has to be found. Depending on any other hazards and significant risks identified in the risk assessment, the footwear may also require other protective features, such as a protective toe cap.

In Europe, safety, protective and occupational footwear is covered by the European Personal Protective Equipment (PPE) Directive 89/686: Annex II: Basic Health & Safety Requirement, Clause 3.1.2.1 Prevention of falls due to slipping, which states: 'The outsoles of footwear designed to prevent slipping must be so designed, manufactured or equipped with added elements as to ensure satisfactory adhesion by grip and friction having regard to the nature or state of the surface'.

Harmonised Standards relating to slip resistance

The main difference between safety, protective and occupational PPE footwear is the level of protection afforded by the toe cap. 'Safety' footwear has a 200J cap, 'protective' a 100J cap and 'occupational' may offer little or no impact protection to the toes.

Tests are carried out according to a set of European and international test standards written into EN ISO 20344. This standard also calls up EN ISO 13287:2012 to test for slip resistance (p11).

The performance specifications, including those for slip resistance, are given in three associated standards:

- EN ISO 20345 for safety footwear
- EN ISO 20346 for protective footwear
- EN ISO 20347 for occupational footwear.

Once tested and certified, the 'CE' mark is applied to footwear products. The manufacturer also provides user information indicating the applications for which the footwear is suitable. Standards exist for other footwear, for example chainsaw users and motorcyclists.

PPE DIRECTIVE – DEVELOPMENT, IMPLEMENTATION AND ENFORCEMENT

PPE Directive 89.686/EEC

As the Directive covers such a broad range of products (typically most products worn or held to provide protection to the user), it divides them into one of three categories. The three categories are based on the risk, consequences and severity of injury likely to occur to someone not wearing adequate PPE. The procedures for demonstrating compliance, and the involvement of organisations known as Notified Bodies (SATRA is a UK-based Notified Body) in the assessment process, differ for each category.

'Simple' design PPE covers products that claim to provide protection against only minimal risks, with effects that are gradual and can be safely identified by the user in good time. Products considered to be 'simple' (also commonly called 'Category 1') are listed in the Directive – washing up gloves being an example. This category of PPE can be 'self certified' by the manufacturer or European importer without the need for the product to be verified by a third party – the involvement of a Notified Body is not required. **Footwear falls into one of the following two other categories if it claims slip resistance.**

'Complex' design PPE covers products that claim to provide protection against risks of mortal danger or dangers that may seriously and irreversibly harm the health of the user. Again, a list is detailed in the Directive. The product has to be certified by a Notified Body, and is subject to initial type examination and on going production checks. This category (also commonly called 'Category 3') includes firefighters' footwear, as well as footwear for protection against molten metal in foundries and high-voltage protection.

All other products fall into a third unnamed category (neither simple nor complex) often called 'Intermediate Design' or 'Category 2'. These are products that claim to provide protection against risks of severe injury. Initial examples of these products and associated documentation must be certified by a Notified Body and the manufacturer then undertakes to make all production the same, and can apply the CE mark. Most safety, protective and occupational footwear falls into this category.

European Harmonised Standards

As the Directive is a general piece of legislation, it does not describe or detail how particular types of product need to be tested. It merely includes health and safety requirements which need to be taken into account for all types of PPE, but to support the Directive, the European Union Commission has mandated the development of various product safety standards via the European Standards agency CEN (Comité Européen de Normalisation). CEN has convened a technical committee (referenced CEN/TC 161 – Currently Chaired by SATRA) in order to develop a series of harmonised European standards to be used in the testing and certification of foot and leg protection.

When European standards for PPE are published, the European Commission carries out a further review and, if they are suitable, they become officially 'harmonised' throughout Europe, and have a 'presumption of conformity' for the parts of the directive detailed in Annex ZA of the standard. Hence, when starting the CE-marking process, it is necessary to review Annex ZA of any harmonised standard to be used to ensure that all relevant clauses of the Directive will be addressed. These harmonised standards are recognised as the preferred route to be used when assessing PPE.

Harmonised standards are not the only means of demonstrating compliance with the PPE Directive. A manufacturer can use any technical specification, as long as it can be shown to satisfy the relevant PPE Directive essential safety requirements. However, if a harmonised standard is available for the particular product being examined, you would need to have a sound technical argument for not using it. In certain areas, such as niche or leading-edge products, there may still be no harmonised standards available, in which case a technical specification detailing how compliance is to be demonstrated must be produced and used.

In the case of safety, protective and occupational footwear, harmonised standards do exist, and the following are considered to be the minimum standards in relation to slip resistance.

Safety, Protective and Occupational Footwear Slip Resistance Requirements

EN ISO 13287:2012 is used to certify safety, protective and occupational footwear. The requirements for Coefficient of Friction (CoF) for safety footwear are:

Surface	CoF values	
	Heel	Flat
Ceramic Soapy Water	0.28	0.32
Steel with Glycerol	0.13	0.18

Note: Steel with Glycerol is considered to be an exceptionally onerous test and the CoF values have been set accordingly.

Footwear which passes will be coded as follows:

- SRA – Slip resistance on ceramic tile floor with SLS*
- SRB – Slip resistance on steel floor with glycerol
- SRC – Slip resistance on ceramic tile floor with SLS* and on steel floor with glycerol.

**SLS = Sodium Lauryl Sulphate solution*

SRC is the most stringent specification

The PPE Directive is enforced throughout Europe by a number of Member State enforcement bodies with the powers to seize and destroy faulty goods. These enforcement authorities are active both at the port of entry and throughout the country, spot checking products on sale. Once identified, unsafe or otherwise non compliant products are identified to all EU Member States and a blanket ban imposed.

If an unsafe product is found in the market place then the outlet that directly supplied the goods is potentially liable. The retailer and in many cases, the distributor or importer (often all three) will be subject to any investigation and subsequent enforcement action. If the manufacturer is also located in an area in which the enforcement authority has jurisdiction then they, too, could be investigated.

Supplying substandard products can have disastrous consequences – ranging from loss of business, financial and reputation damage, through to substantial fines or

even imprisonment if a serious safety offence has been committed.
Safety footwear suppliers need to be sure that what they are selling satifies relevant legislation, not just initial evaluation of EC type examination models but also assessment of subsequent production – identifiable back to the batch being sold.
For further details of how SATRA can help contact safety.products@satra.com

OTHER CONSIDERATIONS FOR THE INDUSTRIAL FOOTWEAR BUYER

Of course, slip resistance and other safety features are not the only concerns of the buyer or end user. There are many other practical considerations:

Wearer acceptance:

- Fitting properties – good range of sizes and width fittings to accommodate the workforce
- Comfort/aesthetics – footwear will not be worn, or will cause dissatisfaction and rejection, if styling is not acceptable or comfort is inadequate for long hours of wear in the given environment.

Workplace suitability:

- Ergonomic design – suitable for carrying out the job (such as climbing ladders or operating equipment) without hindrance or overburdening the wearer
- Compatibility with – should not hinder donning of overalls other clothing
- Hygiene considerations – ease of cleaning.

Economic factors:

- Cost – performance footwear may attract premium price
- Durability – replacement frequency and costs.

Cost is so often the key factor. Good quality performance footwear may be more expensive but may also last longer, thereby reducing long term replacement costs.

Furthermore, reducing the number and severity of accidents is in itself a cost saving exercise through savings in time off work, compensation and other social and employment costs.

FACTORS INFLUENCING SLIP RISK

Human Factors Gait, age, mobility, vision, distraction, reaction time, load carriage.		**Location** Perception of hazards, lighting, obstacles, stairs, ramps, changes of surface.
Footwear Fit, security, soling, tread pattern, construction, flexibility, wear, condition.		**Floor** Type, roughness, hardness, age, wear, maintenance, polish, contamination, spillage.

Human Factors and Location

Some people will be more able to avoid slip hazards than others. Being fit, alert and having good eyesight are major advantages. Carrying boxes or equipment; pushing, pulling or lifting loads; wearing loose or heavy clothing and being distracted by the task, noise or lights can all increase the risk of slip accidents.

The workplace may be full of potential hazards, particularly relating to the underfoot conditions. Poor lighting can make it difficult to see spillages. Entrances and doorways often have different types of adjacent surface – perhaps wet outdoor paving meeting a polished reception hall, which introduces a surprise element. Running, turning corners, climbing up or down ladders, steps and sloping surfaces changes the biomechanics of gait – the forces between shoe and ground change increasing the risk of slip.

Flooring Factors

The type of flooring material (such as concrete, resin, ceramic, steel, wood, glass, rubber and vinyl) affects the achievable level of slip resistance. The surface roughness of the flooring has a significant influence on slip resistance, particularly under contaminated conditions.

Smooth surfaces have particularly low roughness and, consequently, can be very slippery when wet. Rough surfaces may become smooth with age and wear or through layers of polish or other contaminants applied to the surface.

SLIP RESISTANT FOOTWEAR DESIGN

Attributes to look for:

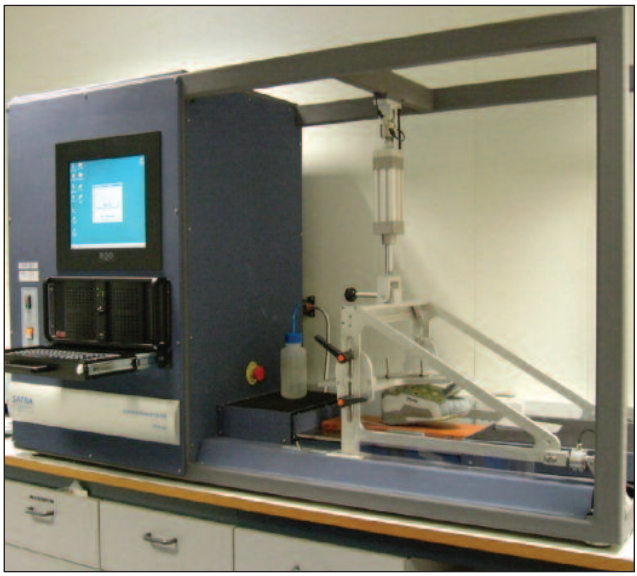
- Fit – good fit means that the footwear is secure on the foot. Shoes that are too big or are loose on the foot have potential to cause instability and loss of balance
- Comfort – a comfortable shoe is less likely to be discarded for an alternative product which may have poorer slip resistance. Also promotes normal gait and reduces fatigue
- Flexible sole – gives the wearer a good feel (proprioception) for the underfoot conditions, sensing slippery or loose, gravelly surfaces
- Flat sole – maximises contact area between shoe and ground
- Low heel height – moulded soles on 'sensible' shoes are ideal; womens' fashion shoes with separate heels become increasingly unstable as heel height increases and top-piece size decreases. Heels should be less than 30mm high with a large, broad top-piece
- High friction materials – a diverse range of rubber and plastic types is used, each in a range of formulations and hardness. Industrial footwear can only be made with a limited range of materials due to the high performance and durability requirements of the PPE standards. These materials are also used in everyday footwear along with many other materials unsuitable for industrial footwear
- Good tread pattern – on clean, dry surfaces a tread pattern is not necessary, but on lubricated surfaces an effective tread pattern is required to sweep aside lubricant in much the same way as car tyre tread.

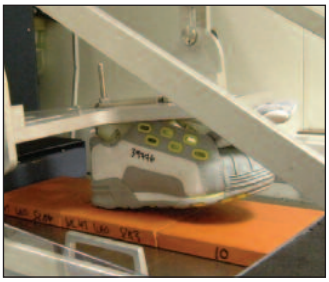
'The real test of design, however, is laboratory testing and wear trials'

SCREENING FOOTWEAR BY LABORATORY TESTING

SATRA uses its STM 603 slip resistance tester to assess products to EN13287. STM 603 is also applicable for testing everyday footwear against the requirements of test method SATRA TM144.

- Heel slip is the most common and dangerous mode of slip in wear. The heel and forepart of shoes should be tested separately
- Comparison of test results on dry and wet surfaces gives a good measure of the effectiveness of the tread pattern
- Standard reference floor surfaces have been defined, but any surface can be used with any contaminant, including soapy ceramic, oily steel and dusty wood.
- Higher levels of coefficient of Friction (CoF) can be applied for higher risk end uses.





RISK ASSESSMENT

When considering flooring and slip resistance, the most important thing to remember is that all floors are suitable, providing they are installed in the correct application and care is taken to ensure that the surface is maintained while other contributing factors are accounted for.

The key to understanding the suitability of existing floor surfaces and, indeed, selecting surfaces for a given application, is to assess a number of important factors. The first consideration is to undertake a slip risk assessment.

What is Risk Assessment?

- Systematic and careful examination of factors (hazards) that could cause harm to people
- Evaluation of whether the controls in place are sufficient to prevent harm.

There are five key points to consider in risk assessment:

1. Identify the hazards
2. Decide who may be harmed
3. Evaluate the risks and decide if the existing precautions are adequate.
4. Record the significant findings
5. Review the assessment periodically.

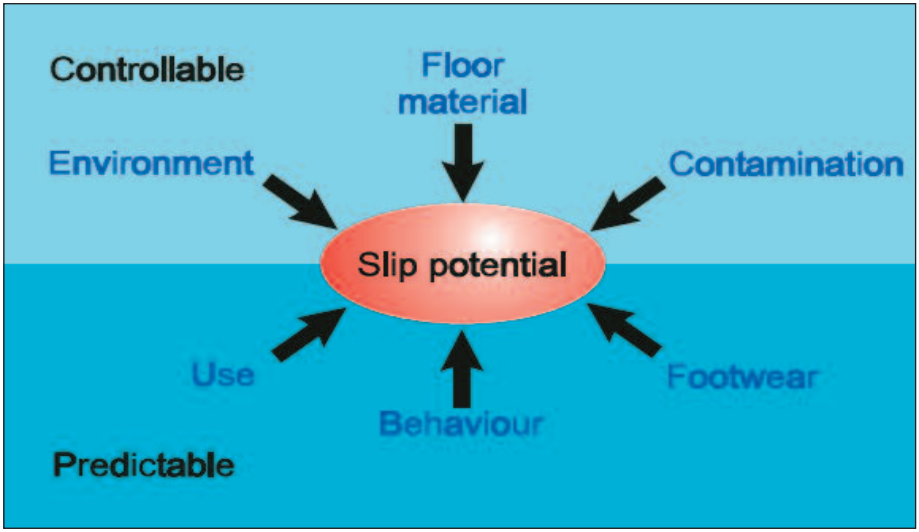
From the results, it is essential that you take remedial action when the controls are insufficient to prevent harm.

And remember...

‘It’s the action, as a result of the risk assessment process, that matters’

THE SLIP POTENTIAL MODEL

A good model to apply when conducting slip risk assessment is the 'Slip Potential Model' (see image below).



(Source: Health & Safety Laboratories)

The essence of the Slip Potential Model is the recognition that a number of issues contribute to the potential for pedestrian slip accidents: it is not sufficient to consider one or two in isolation.

It is by understanding the inter-relationship, and the relevance, of each component in a particular circumstance that a holistic assessment of the slip potential may be made. The slip potential model looks at those factors which are controllable and those which are predictable.

Controllable factors

The controllable factors are those that can usually be changed or influenced by a direct or indirect action; the floor type, the environment, use, footwear (employees only) and the contamination.

Predictable factors

The predictable factors are assessed with an understanding of the final use of the surface in question. The users, their footwear (public access) and the expected behaviour are all significant.

In any site investigation, you should consider the intended application of the floor within the building and associated factors in the area:

- Lighting conditions (make sure that things like poor lighting or glare do not prevent people seeing where they are walking)
- Entrance systems (matting for dirt removal or water absorption and overhangs at entrances can significantly reduce walking water into the building)
- Public and/or employee access (can footwear be controlled?)
- Expected contamination (what dry and wet contaminates can be predicted, are the control measures to deal with them adequate?)
- Maintenance regime (use the correct cleaning method to ensure that the floor's grip is maintained)
- Obstacles, stairs, ramps (are these necessary? If so, are there adequate handrails and visibility?)
- Changes in surface (moving from a surface with high CoF to a surface with a low CoF can result in slips and trips – especially where the users are unable to see the change, such as busy walkways)
- Distractions (what are the possible distractions, such as loud noises, posters, signs, moving screens?)
- Behaviour (what is the expected behaviour in the final application? Are there control measures such as barriers?)
- Expected user groups (different user groups such as children, infirm and the elderly will act differently).

Once you have a full understanding of the application, you can identify the actions that are required.

SUMMARY

The key to occupational slip accident prevention is a systematic and careful examination of things that could cause harm to people and an evaluation of whether the controls in place are sufficient to prevent harm.

If you are a buyer of corporate and employee footwear, you need to ensure adequate slip resistance. The starting point is to meet PPE CE mark slip requirements, but then in addition to test data on EN ISO 13287 (the harmonised European standard for slip resistance assessment used for CE marking), you ideally need to be asking for test results on surfaces that relate directly to end use conditions – concrete, resin, wood, metal, rubber or plastic floors – and likely contaminants.

No one sole design will be best on all different types of surface and contaminants. The following considerations should be taken into account:

Footwear

- Look at tread patterns
- Look at material selection
- Look at test results
- Ask for more information specific to your end use
- Trial samples before buying.

Floorings

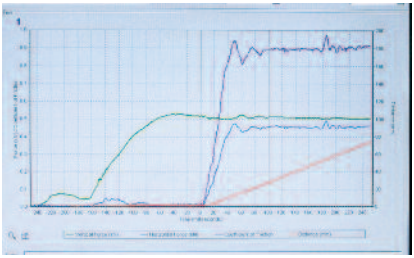
- Select the correct flooring for the application
- Conduct a risk assessment
- Control contamination
- Monitor cleaning and maintenance
- Look at test results
- Monitor performance – changes occur post installation.

DON'T RISK IT

TEST YOUR PRODUCTS FOR SLIP

SATRA STM 603 Slip Resistance Test machine

STM 603 can test a wide range of footwear on various surfaces and simulated conditions, for example dry and wet tile, or frosted and smooth ice. Footwear, surfaces and test conditions can be easily set up. The machine incorporates a specially–designed control and data acquisition system which provides the user with the coefficient of friction for each test sample, as well as providing graphical representation of the test data.



For more information please visit **www.satra.com**
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SATRA is the largest independent international research and technology organisation of its kind serving the consumer product industries. We have a full scope of UKAS accreditation for a wide range of tests.

SATRA is a European Notified Body (no. 0321) capable of testing and certifying all PPE and certain construction products.

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