

SAT WORKS BETTER WITH PTV-CORRELATED DATA

Summary of SAT with PTV-correlated data

In this document we will debunk the HSL claim that the Slips Assessment Tool will only work with Rz microroughness. SAT **will work** with PTV-correlated data and the HSE should encourage use of SAT with PTV as the first step on a journey to raise awareness of slips risks and slip prevention.

- SAT **can work** with PTV-correlated data without changes or re-coding
 - ❖ Repeated claims by HSL that SAT will work only with Rz are untrue as we show below.
 - ❖ SAT works perfectly well with PTV data and the only thing HSE need to do is tell people how to use it and recommend its use with PTV-correlated data
- SAT with PTV offers **far better results** and will improve floor safety
 - ❖ SAT with PTV data offers far better information than SAT with Rz
 - ❖ The combination of a reliable measure of slip resistance (PTV) and subjective impression of other slip risk factors offers duty holders management information to inform decisions and reduce slip risks
 - ❖ SAT with PTV will benefit duty holders and improve floor safety
- SAT with PTV is 1st step on journey of **progressive improvements**
 - ❖ SAT can easily be improved to remove some of the subjectivity and to give greater emphasis to real slip risk situations
 - ❖ SAT can be enhanced to offer more specific advice to duty holders, educating duty holders on specific slip risks and how to manage them
 - ❖ Future developments to include trend analysis showing duty holders how to manage floor safety over time

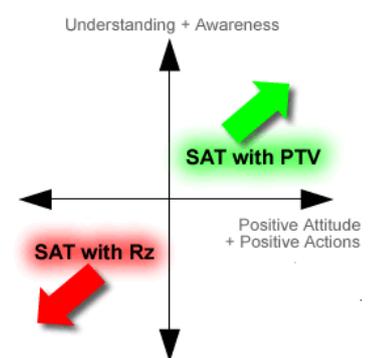
SAT Strengths improved with PTV

SAT is not sophisticated software; however it offers benefits in helping to improve floor safety:

- Educational Benefit for Duty Holders
- "Boffo": magical effect; users do what they are told by a computer programme, especially as SAT is from a reputable organisation like HSE

SAT with PTV will

- raise understanding and awareness of slip risks
- improve duty holder attitudes to the importance of slip management and improve actions taken to prevent accidents and injuries
- increase faith in HSE advice and provide a framework for HSE inspectors to work with Local Authorities and duty holders



SAT CAN WORK WITH PTV DATA (WITHOUT CHANGES)

Since its launch, SAT (the Slips Assessment Tool) has been used exclusively with Rz microroughness measurements as the only objective measure of the slip resistance of the floor. Rz is a poor measure of slip resistance which limits the value of SAT as a means of encouraging best practice in floor safety. However, all is not lost. SAT will work better with PTV assessment of slip resistance and this change to SAT can be made immediately without major re-development work or cost.

HSE claim SAT won't work with PTV

Repeated claims by HSL that SAT that it will work only with Rz are clearly untrue and make no sense. Dr Paul Lemon (HSL), the designer of SAT, claims SAT will not work with anything other than Rz. Paul says,

"I designed SAT and therefore I know what I am talking about. SAT will not work with PTV data without a complete re-design."

This comment suggests ignorance of the facts, but Dr. Lemon designed SAT. He should as he says himself understand how it works.

It would be easy to accept on face value the word of a professional scientist with a PhD, employed by an august body like the HSL. However, it is clear that Dr Lemon's claim makes no sense as we shall demonstrate.

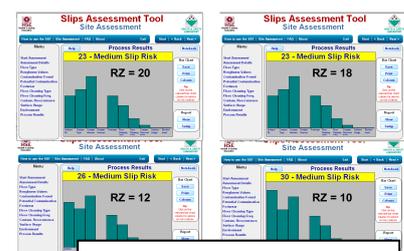
Halving PTV gives very close numeric approximation to Rz

It is immediately obvious that halving PTV gives a very close numeric approximation to Rz when using figures from the boundaries of slip risk categories low, medium, high risk. So unless SAT is very sensitive to the values entered it would seem likely that SAT will work.

PTV/Rz	High Risk	Medium Risk** (most floors)	Low Risk
PTV	<24	24-35	>36
Rz***	< 10	10-19	> 20
Half PTV	< 12	13-17	> 18
Probability of slipping	Worse than 1:20	Somewhere between 1:20 and 1:1 Million	Less than 1:1 Million*
<i>Important notes explained in appendix</i>			

SAT output is not sensitive to the Rz input numbers

As we show in the appendix, SAT output is insensitive to the Rz input numbers and therefore SAT output cannot be affected by entering PTV data with a close approximation to the equivalent numeric values for Rz. This applies across the range of low, medium and high risk situations as measured by SAT and low, medium high risk floors as measured by both Rz and PTV.



SAT almost identical output with Rz slip risk ranging from 1:20 to 1:1 million.

SAT IMPROVED WITH PTV-CORRELATED DATA

- SAT with PTV data offers far better information than SAT with Rz
- The combination of a reliable measure of slip resistance (PTV) and subjective impression of other slip risk factors (degree and frequency of contamination, cleaning methods, control over footwear etc) offers duty holders useful management information that will inform decisions and help reduce slip risks
- SAT with PTV will benefit HSE, duty holders and will improve floor safety

SAT with PTV would be considerably more effective than it is with Rz. Currently, the slip resistance measure is largely ignored by SAT and by SAT users. The other subjective factors, especially the presence of contamination on the floor are dominant in the overall assessment of risk.

With PTV providing a meaningful measure of slip resistance, the existing bias within SAT can be used to advantage and users can be educated to understand the importance of the factors that affect slip risk: the slip resistance of the floor, how it is used by people and the presence of contamination.

In figure 1, SAT has calculated a low risk situation, because the SAT user has answered no contamination present. The left hand column (the slip resistance of the floor) is showing high risk. In this example and on most real floors there is always a risk of some contamination. In this case the floor is mopped (*but not dried*) so it will be wet each time it is cleaned.

Playing to SAT Strengths

SAT is not a sophisticated piece of software, however it offers some benefits in helping to improve floor safety:

- Educational Benefit
- “Boffo”: the magical effect on users who do what they are told by a computer programme – especially computer software supplied by a reputable organisation like HSE

If users were encouraged to use PTV instead of Rz for the measure of slip resistance, then the educational value of SAT would be much improved. The situation in figure 1.1 and high value of the left column of SAT output highlights the need for good management of the floor. While the floor is dry and clean the risks are low as indicated by SAT, but in this scenario the risks increase dramatically if there is contamination, because the slip resistance of the floor is poor.

SAT input categories
There are 10 input categories, Rz is one of the ten.

- Floor Type
- Roughness Values
- Contamination Found
- Potential Contamination
- Footwear
- Floor Cleaning Type
- Floor Cleaning Freq.
- Contam. Reoccurrence
- Surface Usage
- Environment



Figure 1 Low Risk Situation
High bars denote high risk. Left hand column is based on Rz measurement of high slip risk of the floor.

SAT PROGRESSIVE IMPROVEMENT

The HSE has invested a great deal in SAT: time, resources, money. It has been the focus for duty-holder assessment of slip risks for many years and has been at the centre of various high profile campaigns: STEP and Shattered Lives. As we have seen, SAT has educational value and can be developed to improve duty holder understanding of slip risks and to encourage appropriate duty holder action to prevent slip accidents.

SAT Strengths improved with PTV

SAT with PTV will raise understanding of slip risks and improve duty holder attitudes and respect for HSE. Deliver a measurable improvement in floor safety and reduction in slip accidents and slip injuries. Increase faith in HSE advice and provide a framework for HSE inspectors to work with Local Authorities and duty holders.

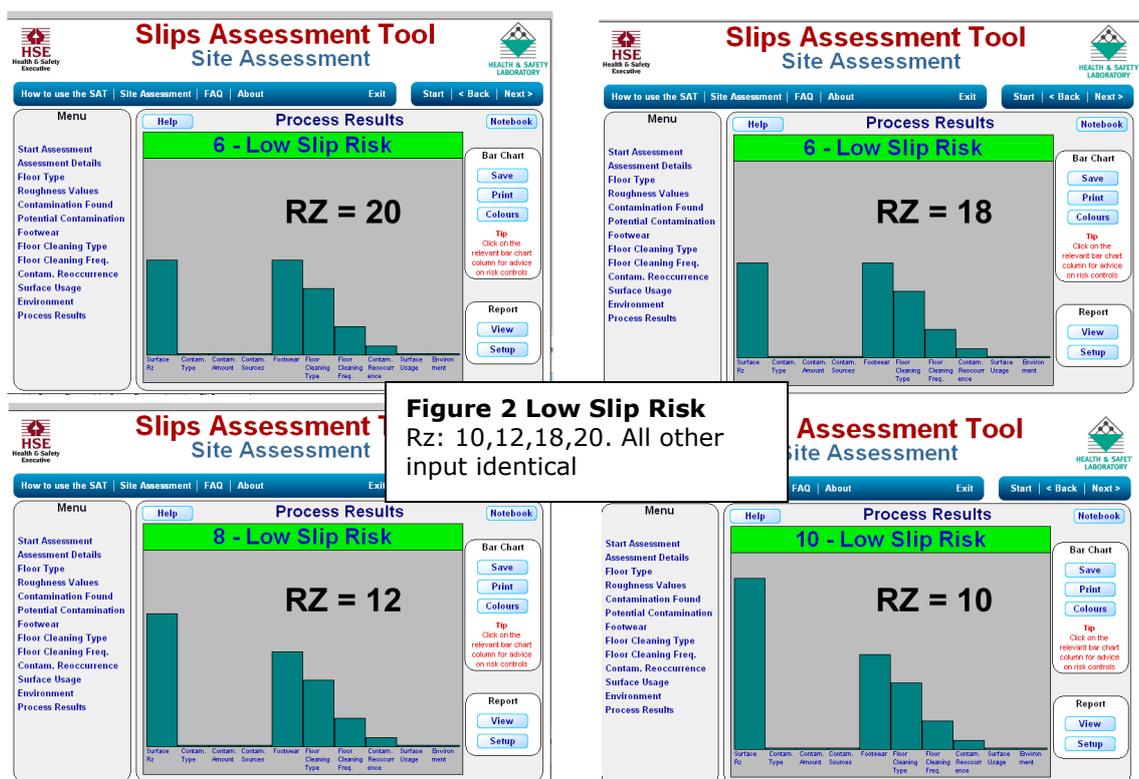
- Easy and quick improvements to SAT
 - ❖ Many SAT users find the combination of questions quite subjective: e.g. contamination: it is unclear how to answer this unless users are clear whether the answer is for a one-off examination of the floor or in general.
 - ❖ Wet contamination of floors is always possible and a combination of water + grease or oil will dramatically increase slip risks, so SAT should consider water separately from other contaminants
- SAT and more specific advice to duty holders
 - ❖ SAT could be developed to educate duty holders on specific slip risks and how to manage them
 - ❖ if the floor has high slip risk (PTV) when wet and is mopped users should be aware that until the floor is dry it should not be walked on.
 - ❖ Some floors dry quickly (porous concrete), some dry very slowly (metal or resin), duty holders should understand the risks to different floors while drying and how this affects cleaning patterns
- Future developments and trend analysis
 - ❖ SAT can be developed to include a trend analysis module allowing users to understand "at risk" floors and how the slip risk changes over time.

APPENDIX SAT OUTPUT NOT SENSITIVE TO RZ VALUES ENTERED

Below we demonstrate that SAT output is not sensitive to the average Rz values entered by showing SAT output from low risk, medium risk and high risk SAT output with various values of Rz.

SAT low risk output input values from low, medium and high risk

- ❖ Floors with Rz value of 20+ should present a low slip risk
- ❖ Floors with PTV 36+ do present a low slip risk (36 halved = 18)
- ❖ Floors with PTV below 24 do present a high slip risk (24 halved = 12)
- ❖ Floors with Rz below 10 should present a high slip risk



The four images are identical SAT input except for the variance in the average values of Rz entered as shown in each image. Note: SAT has assessed all four cases as low risk. In this example, SAT considers the floor to be low risk because there was no contamination present. However, floor is wet mopped! With poor slip resistance Rz = 10, this floor could be a high slip risk each time it is cleaned (regularly).

Slip Risk:	Low Slip Risk (10)
Floor Type:	Ceramic Tile
Contamination:	None
Footwear:	No control over footwear
Floor Cleaning Types:	Wet mopped
Floor Cleaning Frequency:	At regular intervals
Contamination Reoccurrence:	Very little or no recontamination

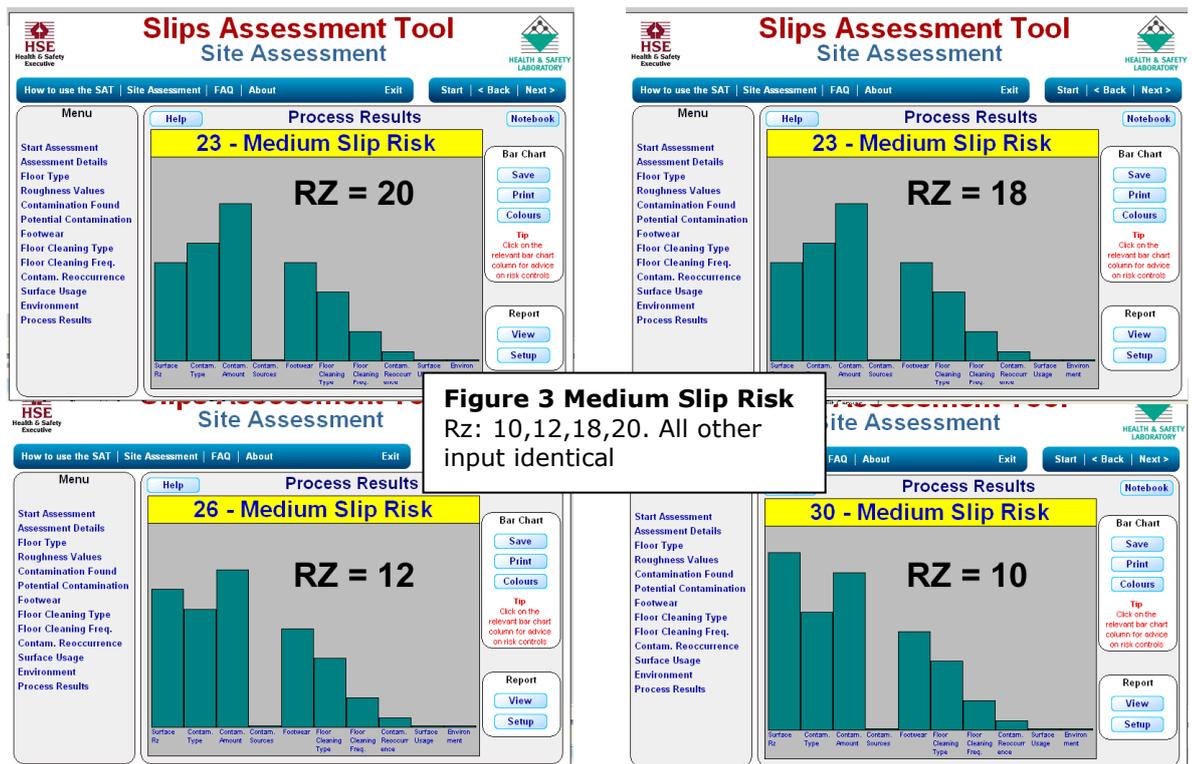
SAT input categories
There are 10 input categories, Rz is one of the ten.

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SAT medium risk output

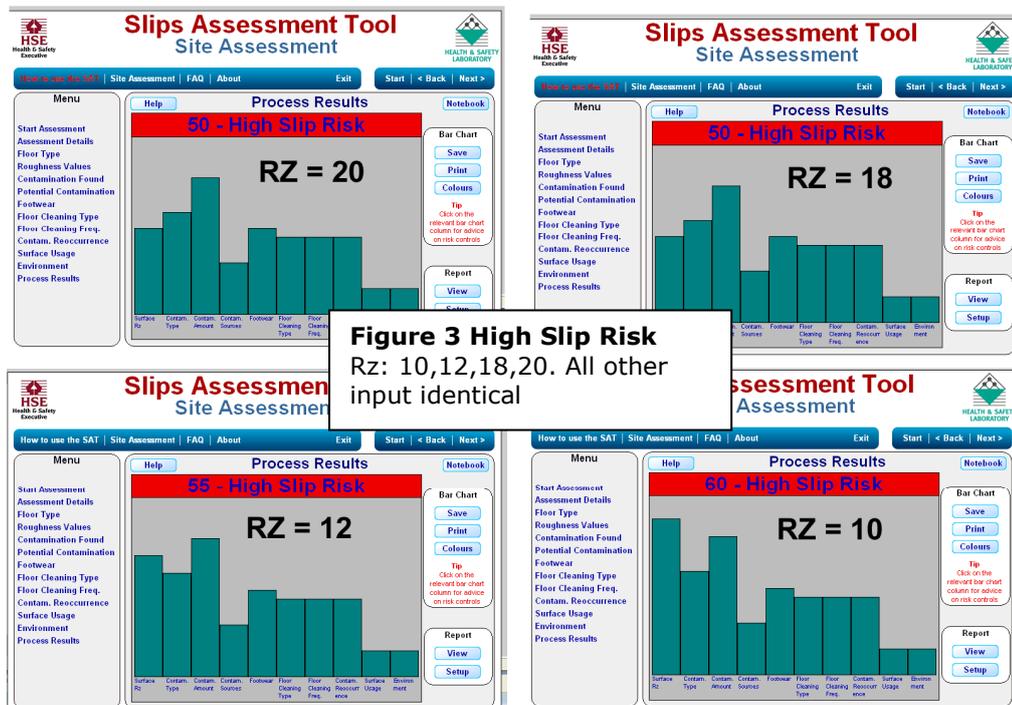
- ❖ Floors with Rz value of 20+ should present a low slip risk
- ❖ Floors with PTV 36+ do present a low slip risk (36 halved = 18)
- ❖ Floors with PTV below 24 do present a high slip risk (24 halved = 12)
- ❖ Floors with Rz below 10 should present a high slip risk

The four images are identical SAT input except for the variance in the average values of Rz entered as shown in each image.



SAT HIGH risk output

The four images are identical SAT input except for the variance in the average values of Rz entered as shown in each image. In this case SAT considers the situation high risk in every case because of water based contamination present. The overall risk does not change even on floors with a slip resistance which should give less than 1:1 million chance of slip.



- | | |
|------------------------------------|---|
| Slip Risk: | High Slip Risk (50) |
| Floor Type: | Ceramic Tile |
| Contamination: | Water-based, Medium |
| Contamination Sources: | Spillage from machinery, Proximity to canteen |
| Footwear: | No control over footwear |
| Floor Cleaning Types: | Other - ineffective |
| Floor Cleaning Frequency: | Seldom |
| Contamination Reoccurrence: | Re-contaminated soon after cleaning |
| Surface Usage: | Pedestrians with disabilities |
| Environmental Factors: | Unexpected loud noises, Near other distractions |

SAT input categories

There are 10 input categories, Rz is one of the ten.

- Floor Type
- Roughness Values
- Contamination Found
- Potential Contamination
- Footwear
- Floor Cleaning Type
- Floor Cleaning Freq.
- Contam. Reoccurrence
- Surface Usage
- Environment

Note: changes to floor type make no difference to the output with the exception of carpet where SAT warns the user that Rz cannot be taken on carpet. We know that Rz results are very different on different floor types.

SAT INPUT OF PTV-CORRELATED DATA

The following table shows the boundaries of high, medium, low slip risk for both PTV and Rz. It is important to note that in the apparently very narrow range from PTV 24 to PTV 36, the slip risk changes from 1:20 to 1:1 Million. This range PTV 24 to PTV 36 is the most important range for duty holders to understand. It is in this range that many floors require careful management and in this range that slip accidents can be prevented. Floors that present a higher slip risk than 1:20 are often changed or replaced. Normal floors that present a slower slip risk than 1:1 Million will rarely be tested and rarely have slip incidents.

PTV/Rz	High Risk	Medium Risk** <i>(most floors)</i>	Low Risk
PTV	<24	24-35	>36
Rz***	< 10	10-19	> 20
Half PTV	< 12	13-17	> 18
Probability of slipping	Worse than 1:20	Somewhere between 1:20 and 1:1 Million	Less than 1:1 Million*

Notes:

* If a floor has PTV >36 when wet, then it is considered safe for walking. The 1 per million relates to 1 person in a million, not 1 fall for every person walking over the floor. In a supermarket for example there may be a million visits made by just 60,000 people none of whom will slip. In most cases floors will be slip free even with PTV in the medium range when wet, because the floor is rarely wet and has far fewer than 1 million different people walking upon it.

** The range of PTV from 24 to 36 is most important, because in this range floor slip risk changes dramatically from 1:1 million to just 1:20 a factor of 50,000 greater risk.

*** Rz is a poor measure of floors in the medium range (*the floors that should be regularly monitored regularly*). 64% of floors with Rz between 10 and 20 will NOT present medium slip risk. In the range Rz 11-19 there is no noticeable relationship between changes in Rz and changes in slip risk from 1:20 to 1:1 million! Therefore Rz is not helpful in this area.

SAT INPUT

SAT input is good and bad. Some fields offer excellent images to help the user assess the levels of contamination. While other fields leave the user puzzled as to how they should answer.

- *"Some of the decisions are quite subjective and in practice I end up guessing at some of the answers. The re-contamination does not always fall into the categories shown."*

Below we consider the ten input fields and how they affect the output and risk assessment of the floor.

SAT input categories
There are 10 input categories, Rz is one of the ten.

Floor Type
Roughness Values
Contamination Found
Potential Contamination
Footwear
Floor Cleaning Type
Floor Cleaning Freq.
Contam. Reoccurrence
Surface Usage
Environment

- **Floor Type:** SAT largely ignores the floor type. Except for: carpet, where Rz will not work, and ceramic tiles, where there is an additional question on acid-etching. **Note:** Rz cannot detect the effects of acid etch so it is assumed to have made small improvement. Acid-etching can make a profound improvement to slip resistance or can make little improvement and make the floor harder to clean.
- **Roughness Value:** This data is given less weighting than the subjective measures such as level of contamination. If this were changed to PTV-correlated data, then far more use could be made of this result.
- **Contamination Found:** this should be changed to consider water contamination separately from other contamination. PTV tests can be done both wet and dry and before/after cleaning to make this a much more meaningful data set. **Note:** one of the best features of SAT is the images of contamination levels that help the user with estimating subjective values.
- **Potential Contamination (sources) + Contamination Reoccurrence :** this is useful for educating users on how contamination may occur and may be prevented.
- **Footwear:** SAT assumes that control over footwear is a positive (i.e. safety shoes), but makes no allowance for sports halls where socks may be the controlled footwear.
- **Floor cleaning Type + Floor cleaning Frequency :** a floor with no contamination found gets low slip risk – even if it is wet mopped frequently!
- **Surface Usage:** this field considers unusual usage factors such as people carrying heavy loads, but should also consider levels of footfall – how many people on a floor per day will influence the risk of falls.
- **Environment:** factors such as lighting, noise and distractions will have much greater impact when the floors have low slip resistance or where many people are moving fast or carrying heavy loads.

SAT SURVEY AND THE IMPACT OF RZ ON SAT USERS

The recent survey of SAT users provided interesting feedback that should not be ignored. HSE must be worried that there is feedback from less than 50 non regulatory users of SAT who have a roughness meter. Thousands of copies of SAT have been downloaded. Hundred of Surtronic Duo's have been sold (data from Taylor Hobson), yet there were less than 50 responses from non regulatory users with roughness meters.

Comments on Rz meters

There were less than 50 responses from non-regulatory SAT users who own a roughness meter so the following list of comments must suggest a large proportion of SAT users have concerns about Rz.

- *“Seemed to give error messages in some locations (always the same) as though there might be interference but nothing could be identified”*
- *“On occasions the range of readings appears to be erratic and does not follow an expected pattern /trend”*
- *“Overly complex for a limited use, excessive costs and the lack of product lease/hire, showed that the safety product service market, is not responding effectively to HSE led safety improvement initiatives”*
- *“Too expensive and not the right tool”*
- *“OK but Rz is of limited use, a better parameter would be preferable if it can be measured economically”*
- *“It is a bit temperamental at times showing ‘error’ when I have been using it the same way on the same surface.”*

These are comments from the small minority of SAT users who bothered to respond to the survey. How would they feel if they knew that they could get just as good an indication of slip risk by tossing a coin?

SAT users comment on SAT itself

- *“Some of the decisions are quite subjective and in practice I end up guessing at some of the answers. The re-contamination does not always fall into the categories shown...”*

How would this user feel if he/she knew that the Rz measure, the only quantitative measure used by SAT is no better than a guess?

SAT users and "positive" actions

The following comments represent "positive" actions taken by duty holders based on Rz test results used with SAT. You will see they provide evidence that increased dependence on Rz test data will have dire consequences for floor safety.

- *"The results showed minor risk "*
 - There is a 64% chance that this duty holder has been misinformed by the Rz result. And an 11% chance that the risk is 50,000 times greater than the duty holder believes.
- *"We identified one area using the tool which was a painted wooden surface, this has been altered after looking at the risk rating and has been changed to a profiled floor. "*
 - HSL tests suggest that profiled floors are not always safer and HSL test acknowledge that Rz is a poor measure on profiled floors. How will the duty holder know that the new floor is safer? There is a good chance that it is not.
- *"SAT tool has enabled us to monitor some wear on a 2 year old floor surface walkway, the risk rating is in the low category but tool will enable us to monitor and take action as necessary "*
 - Evidence suggests that Rz cannot detect changes to slip resistance caused by wear so the regular testing will be a waste of time and if there floor is now a risk or if it becomes a risk, the duty holder will not discover that risk until more people slip or fall.
- *"Altering floor surface - removing varnish, returning to natural wood. "*
 - The duty holder presumably believes that the varnished surface is a greater slip risk than bare wood or wood coated with a matt wood stain. That is not always the case and Rz is a very poor measure of slip

SAT user actions with PTV-correlated data

When SAT is used with PTV-correlated data, there will be much greater dependability of the output. The subjective factors can be used as a way to educate duty holders and their staff and to build awareness of factors that can be controlled and changed to improve slip risks. The objective values of PTV can be used to assess the relative risk of a floor and how best to manage the risks.

HSE inspectors can work with duty-holders to encourage best practice in floor safety and can use the SAT information and PTV data to encourage informed decision making that will reduce slip risks.

