

London Underground Escalator Passenger Safety Strategy Improving Passenger Safety on Escalators

Phil Harley, Kevin Seaborne

15 Westferry Circus, Canary Wharf, London E14 4HD, UK. philipharley@tfl.gov.uk
Victoria Station House, 191 Victoria St, London SW1E 5NE, UK. kevin.seaborne@tube.tfl.gov.uk

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Abstract. Safety, reliability and value for money are at the foundation of London Underground's (LU) service. Although LU's safety record is one of the best in the world it is important to guard against complacency and continue to strive for continuous improvement.

Evaluation of company incident data has identified that the largest cause of customer injuries on London Underground is slips, trips and falls with 40% of all injuries reported occurring on escalators.

A strategy group was set up, comprising all stakeholders across the business, to identify/shortlist and then trial ideas to improve passenger safety. Four key risk controlling measures were identified and from the list of ideas 12 were shortlisted for trial on more than 50 escalators at stations with historically high accident rates. The aim was to identify ideas that would positively impact passenger behaviour and in turn reduce the number of slips trips falls and entrapments.

Four measures were used to evaluate the effectiveness of each initiative. Seven of the twelve ideas were found to be effective, following evaluation of the four measures.

The next step is to roll out, in a targeted manner, selected initiatives to "Top 20" London Underground station assets where the highest number of accidents and incidents have occurred in previous years.

1 INTRODUCTION

An escalator is an inherently dangerous machine by modern safety / engineering standards, in that passengers are directly in contact with moving powered machine parts, with minimal guarding between moving steps and static landings and balustrades. The high prevalence of slip / trip / fall incidents on escalators, along with less regular but potentially far more serious entrapment incidents, are mainly caused by customer behaviour.

There are various issues where the passenger is exposed to risk and adopts behaviours which do not best mitigate these risks.

- To avoid entanglement, entrapment or risk of fall, the safest place to stand on the step is with feet equidistant from the front and rear edges, and away from the edge of the step and the brush guard.
- The most dangerous area of the escalator is the landing where the interface between the static landing and the moving step way is protected by the comb plate.
- Holding the moving handrail whilst transiting the escalator is the most reliable way to reduce the risk of slips, trips and falls.
- Many accidents occur on escalators due to passengers being mobility impaired, whether by carrying luggage, holding young children, or due to age or infirmity.

2 FORMING THE STRATEGY

The intent of the Escalator Passenger Safety Strategy (EPSS) is to improve both reliability and safety of the customer experience; the benefits are primarily social with fewer customers injured. Financial savings are seen in reduced compensation payments, and reduced costs due to diversion of staff from primary duties. Following an accident, escalators are often removed from service for a period pending inspection and therefore inconveniencing other customers, and any reduction in accidents will logically reduce this necessity. However, the primary benefit is to demonstrate commitment to safety and high standards of customer care.

The purpose of the EPSS is to identify effective methods of influencing passengers' behaviour to increase their safety on escalators. The Imperial College London CoMET 2010 Case Study, states:

“It is striking that two metros – Metro A & Metro B1 – have consistently and progressively reduced the number of falls (on escalators) as a result of systematic management attention, appropriate investment and good campaigns to persuade passengers to avoid behaviour that would put them at risk” [1]

A census of CoMET members was conducted in 2013 to determine best practice in other Metros which was taken into account when determining which customer behaviours should be encouraged.

Due to the high prevalence of injuries on escalators not due to machine failure, there is a need to inform the passenger either directly or subliminally of safe practices for transiting escalators. This can be broken down into four main themes, or mitigating messages:

- Hold the handrail.
- Walk / stand safely.
- Be aware of the step / landing interface.
- Where possible, use lifts when mobility impaired.

These four core messages are embodied in the 12 different initiatives, technical interventions with the specific purpose of altering passengers' behaviour either by direct information or subliminal coercive “nudges”.

3 FORMULATION AND DEVELOPMENT OF THE EPSS COMMITTEE PLAN

The strategy is designed as a loose framework document. It caters for ongoing initiatives to be overseen and directed, and also for the scoping and support for as yet unstarted projects. In order to ensure stakeholder support for this strategy the EPSS committee was convened to propose & agree a system wide risk based approach, with representatives invited from the following stakeholders:

- LU Engineering
- LU Stations Maintenance
- Projects Directorate
- Strategy & Service Development
- Health, Safety & Environment, LU Ops
- Technical Head of Discipline, Lifts & Escalators
- LU Stations Operations

¹ CoMET is a group of Metros across the world which cooperate in Benchmarking. CoMET reports are subject to confidentiality. It is not permissible to name participating organisations in public documents.

A plan was formulated to develop all selected initiatives and install in suitable locations by 1st September 2015. It was agreed at an early stage that buy in from across the network would be essential. To this end, presentations to stations personnel informing them of the EPSS aims and progress have been carried out, along with the production of publicity in the form of articles in “On The Move” magazine and other internal media.

4 SUCCESS CRITERIA

The criteria for judging an initiative successful has been deemed to be a reduction of 10% of escalator related accidents. Due to the small scale of the trials and the resultant low level of statistical data available, this cannot be fully inferred from review of reported accidents on escalators. To compensate for this, it was agreed that reduction of incidents can also be inferred from an increase in safe behaviours, or decrease in unsafe behaviours. In addition, survey of staff on stations where initiatives are installed gives a further perspective on effectiveness, and a technical review gauges the practicality of each initiative.

5 SELECTED INITIATIVES FOR TRIAL

From a wide array of suggested alternatives, 12 asset initiatives were identified as being most likely to affect customer behaviour and enhance customer safety. Some of these interventions are new approaches, whilst others are industry standards.

5.1 Passenger Positional Guides (PPG)

Bi-directional footprints intended to guide passengers in their safe foot positioning whilst riding on escalators.

5.2 Step Edge Painting

Industry standard painting of step edges to highlight safe area to stand upon.

5.3 Step Riser Messaging

Safety messages stencilled on the black step risers.

5.4 Red Lexan Combs

Red escalator combs manufactured from Lexan polycarbonate, highlighting the interface between the moving step band and the static landing.

5.5 Under Step Lighting

White light shining up through the gaps between steps at the top and bottom landing to highlight changing geometry of the step in the transition between the landing and the incline and nearing the end of the moving stepway.

5.6 Over Comb Lighting

Lighting element installed in the balustrade at foot level directly over the comb to highlight transition from landing to step band to stationary landing.

5.7 LCD Screens in Pattresses “e-Toblerone”

High definition bi-directional screens displaying safety messages mounted inside Pattresses on the balustrade between escalators.

5.8 Embedded Handrail signage

Safety messages permanently embedded in the surface of the handrail.

5.9 Virtual Assistant Projector “Hologram”

Mobile “Virtual Assistant” silhouette projector unit to impart safety messages installed near escalators.

5.10 PA Messaging

Modified PA announcements for particular station areas giving safety messages for a bank of escalators.

5.11 Escalator Floor Vinyls

Temporary floor signage to encourage people to take caution when using an escalator and hold the handrail.

5.12 Lift Floor Vinyls

Temporary floor signage to enhance awareness of station lift locations and encourage customers to use the lift instead of an escalator if mobility impaired.

6 REJECTED INITIATIVES

The following initiatives were investigated, evaluated and then rejected during the progress of the EPSS:

6.1 Coloured Step Brush Holders

Extruded aluminium holders of escalator brushes are normally unpainted; to highlight the risk of entrapment in the step edge it was suggested that the brush holder be powder coated red. This was deselected due to cost and due to insufficient numbers of escalators such an installation would be practicable on. A report was produced detailing the decision. [2]

6.2 Step Riser Painting

As an initial proof of concept trial, escalator 4 at Heathrow T1-3 had step risers powder coated yellow during a refurbishment to highlight the step to step gap. This was deselected due to issues with ambience, and the requirement to remove the escalators from service for a period to effect the powder coating. A report was produced detailing the decision. [2]

6.3 Directional Indicators

Directional indicators are “traffic light” signals which are intended to inform passengers of the direction of travel of an escalator (by means of a green arrow or a red stop light). This concept was investigated and deselected as no evidence was found that (a) it would prevent customers boarding escalators in the wrong direction, or that (b) that this is a problem which merits intervention. A report was produced detailing the decision. [2]

6.4 Onboard Train Announcements.

Operational staff suggested the inclusion of train onboard messages informing passengers of the location of lifts prior to arrival at the station, to increase awareness of lift facilities at stations and to direct mobility impaired passengers and passengers with heavy luggage to the nearest lift. This was deselected due to the review highlighting the difficulty involved in the implementation of this initiative. It also showed no evidence of its effectiveness. Furthermore overloading train passengers with messages will effectively diminish their intent, rendering existing safety messages ineffective, and reduction of onboard messaging is a priority for operational staff. A report was produced detailing the decision. [2]

7 INSTALLATION

Installation of the selected initiatives was carried out by a variety of internal and external bodies, using assets and manpower provided by either EPSS internal stakeholders or by contractors and suppliers of specific equipment and services. The majority of installations were completed on schedule whilst a minority of the more innovative and complex initiatives were delayed due to supply or technical difficulties.

8 MEASUREMENT OF EFFECTIVENESS

The reason for inclusion of known systems as well as new concepts in the trial is simple: there appeared to be very little independent assessment of their effectiveness in encouraging safe behaviours. Therefore as part of the trial it was necessary to establish the effectiveness of both established and new methods for altering customer behaviour. This measurement of effectiveness was conducted in four ways: statistical comparison, survey of passenger behaviours, technical evaluation and survey of station staff.

8.1 Statistical Comparison

The sites for the escalator initiatives trials were reviewed and across the 20 stations with trials in place there was a reduction in incidents with injuries overall by 3%. This was a comparison of customer injuries over the trial period of 2015/16 September - March inclusive compared with 2014/15 September - March. The same periods each year were compared to allow for seasonal fluctuations and holiday periods etc. It was noted there was a reduction in Customer Major Injuries by 36% (major broken bones, unconsciousness or dislocations) at the trial stations. The data only includes incidents reported to staff and involve an injury to the customer.

8.2 Survey of Passenger Behaviours

Surveying passenger behaviours to accurately judge the effect of the initiatives was conducted primarily by collection of CCTV data from before installation, directly after installation, and following 3 months deployment. Where insufficient quality of image was available from CCTV we temporarily installed GoPro cameras to record at the same periodicity.

8.3 Technical Evaluation

The technical effectiveness of the initiatives was examined throughout the trial (robustness, wear, impact on maintenance etc), along with their impact on the Stations' environments. This process combined regular visual inspections of the installation sites with collation of faults reported.

8.4 Station Staff Survey

The survey of station staff gives further depth to the analysis, by gaining their subjective insight into the effect on passengers' behaviour over the length of the trial. Site specific questionnaires were produced, referring only to initiatives installed in each station, and were distributed Jan – Feb 2016. Front line staff and station managers were talked to about the initiatives before the trials started at 6 of the key stations and during the trials. All the stations were emailed and posters sent out for comms. Over 100 staff were spoken to and there were 92 responses collated from the staff feedback survey completed between the 3-4 month period of each of the trials. There were mixed responses from staff and some staff were unaware of the initiatives due to a major reorganisation having just taken place on stations, resulting in a larger than average number of new staff at the stations visited.

All station area managers were asked for feedback and staff surveys to be completed. Feedback was limited so a team went out to interview front line staff. A short survey of staff observations and feedback was completed covering the following areas:

- Have there been any maintenance changes?
- Any change in failures observed?
- What change in customer behaviour has been observed?
- Is there a change in customer accidents?
- Any issues with the installation?
- Any comments of positive actions or improvements

These four methods of measurement were combined to provide a robust assessment of the effect of each of the initiatives on passenger safety, their robustness and utility in service, and the practicality of wider use. The assessments provide evidence to support recommendations for wider deployment of a specific initiative where warranted. Validation of the measurement of the survey customer behaviours was conducted by the Customer & Employee Insight Team of the Marketing and Communications Directorate, and the methodology was found to be impartial and effective.

9 RESULTS

Listed in the table below are the scores on each of the measurements of effectiveness, giving an overall indication of how effective each of the initiatives was found to be.

Table 1: Summary of Trial Results

Initiative	Statistical Analysis (Accident reduction >10% ²)	Final Customer Behaviour (>10% ²)	Staff Survey	Technical Review	Overall Effective Decision
PPG (Blue Footprints)	27%	21%	Neutral	Pass	Yes
Step Edge Painting	-29%	2%	Negative	Fail	No
Step Riser Messaging	-20%	13%	Positive	Pass	Yes
Red Lexan Combs	36%	15.90%	Positive	Pass	Yes
Under Step Lighting	0%	0.08%	Negative	Pass	No
Top Comb Lighting	0%	2.10%	Negative	Pass	No
e-Toblerones	-21%	11.20%	Positive	Pass	Yes
Embedded Handrail Signs	23.80%	17.40%	Positive	Pass	Yes
Hologram	13.10%	19.90%	Positive	Pass	Yes
Speakers / PA	Nil	Nil	Nil	Fail	No
Escalator Floor Vinyls	-9%	7.60%	Negative	Pass	No
Lift Floor Vinyls Vinyls	22%	1.10%	Positive	Pass	Yes

A final report was published and disseminated on completion of the trial, detailing the findings. [2]

² >10% refers to the success criteria of reducing accidents – or unsafe behaviours – by more than 10%.

10 RECOMMENDATIONS

The following recommendations were made in the final report, and were approved by the Customer Safety Strategy Steering Group:

10.1 Passenger Positional Guides

It is recommended that PPGs should be installed on escalators which are known to run predominantly in one direction, with identified issues of passenger foot placement causing accidents, and that repainting should be programmed in on a six monthly basis.

10.2 Step Riser Messaging

It is recommended that “Hold the handrail” step riser messages are installed on escalators with non-cleated step risers which run predominantly in an upward direction.

It is also recommended that further development of a solution for steps with cleated risers is funded and managed via the EPSS.

10.3 Red Lexan Combs

It is recommended that red combs continue to be rolled out where applicable over the LUL network escalator fleet.

It is also recommended that the practicality of extending the use of red combs across all escalators.

10.4 LCD Screens in Pattresses “e-Toblerone”

It is recommended that further development of this initiative is funded, potentially with support from commercial interests.

It is further recommended that the installation at Piccadilly is retained for 12 months to establish the long term reliability of the technology.

10.5 Embedded Handrail Signage

It is recommended that message embedded handrail should be identified and approved as the standard replacement for Shape 400 handrails (non V-type), as part of their programmed replacement. This should be captured in the CAT1 Standard as a mandatory requirement.

10.6 Virtual Assistant Projector “Hologram”

It is recommended that a small fleet of Virtual Assistant Projectors is purchased, to be used as a moveable safety messaging resource.

10.7 Lift Floor Vinyls

It is recommended that lift “breadcrumb” vinyls should be installed at Wide Access Gates in station gate-lines, where confusion over direction to the lifts for mobility impaired customers has been identified. Signage should be replaced on a six monthly basis.

10.8 Escalator Passenger Safety Strategy Committee

It is recommended that the EPSS committee is retained in its present form to act as an authorising “clearing house” for future suggested escalator passenger safety initiatives and a management framework for future projects; reporting to the Customer Safety Strategy Steering Group.

These recommendations now form the basis of the ongoing plan for targeted deployment of successful initiatives to stations. This is achieved by identification of “top twenty” London

Underground stations assets by examination of historical data where the highest number of accidents and incidents have occurred in previous years. Selection of a specific initiative for a site is agreed through consultation between local station operational staff, engineers, maintainers and S&SD prior to installation.

11 UNSUCCESSFUL INITIATIVES

The following initiatives were found to be unsuccessful in promoting safe passenger behaviours on escalators

11.1 Step Edge Painting

Painting of yellow step edges on single piece cast steps had no significant measured effect on customer behaviour or safety. Allied to the restrictions of painting cast steps only and the requirement for access to the step band in the machine chamber, there is no advantage in pursuing this initiative.

11.2 Under Step Lighting

Installation of lighting beneath the ends of the moving stepway was found to have no significant measured effect on customer behaviour or safety. There is no evidence to support any further deployment of this initiative. However whilst there is no benefit to further installations, there is little point in removing any under step lighting installed, as there is no disbenefit to their continued use.

11.3 Over Comb Lighting

Installation of lighting above the escalator landing combs was found to have no significant measured effect on customer behaviour or safety. There is no evidence to support any further deployment of this initiative. However whilst there is no benefit to planning further installations, there is little point in removing any under step lighting installed. There is no disbenefit to their continued use, and to do so would require the escalators' removal from service whilst the removal was effected.

11.4 PA Messaging

Recorded PA announcements specific to escalator safety were installed in the PA system for the northern concourse of Kings Cross St Pancras. Initially the recordings were played, but were found by station staff to be "cluttering" the PA, and the messages were removed. These initiatives were not fully submitted to trial, and results did give a representative view of their effect on customer behaviours. However the intent of station staff to minimise "clutter" on PA systems in stations is widespread, and as such precludes further development of this initiative.

11.5 Escalator Floor Vinyls

Although initially promising, escalator floor signage had only a temporary effect on the behaviour of passengers. An initial 15.9% increase in safe behaviours (holding the handrail), reduced over the course of the trial to 7.6%. Over the trial period reported accidents increased by 8%. Concern with passengers being distracted when approaching the escalators, and likelihood of the message being obscured in busy periods was raised. There is insufficient evidence to support any further deployment of this initiative.

12 CONCLUSION

The collaboration between the wide and disparate grouping of stakeholders across London Underground resulted in the delivery of twelve discreet initiative designs which have been trialled on operational escalators and stations. The EPSS committee is a useful conduit for the review, discussion and approval of any suggested improvements to customer safety on escalators, under the authority of the Customer Safety Strategy.

In development of the EPSS involvement has been sought from a wide array of external organisations, including the Community of Metros (CoMET, the international forum for metropolitan rail transport providers), the Construction Industry Research & Information Agency (CIRIA), Health & Safety Laboratories (HSL, an agency of the Health & Safety Executive) and the Office of Rail & Road (ORR), along with a number of manufacturers and suppliers.

It is intended that the final report will act as a record of the selection process of all suggested initiatives, both those trials undertaken and those which were rejected. This will enable the minimising of future nugatory effort by concisely stating the reasons for selection or deselection, and where trialled recording evidence of effectiveness.

Photographs of all initiatives of the EPSS trial are included at Annex A.

REFERENCES

- [1] CoMET 2010 Case Study – Station & PTI Safety, Final Report, 01/07/2011
- [2] STN 271-6 Escalator Passenger Safety Strategy, Final Report, 01/04/2016

BIOGRAPHICAL DETAILS

Phil Harley IEng MSOE

Phil Harley is an Incorporated Engineer of the Society of Operations Engineers. He holds the post of Senior Engineer of the Ops LU Engineering Stations Equipment Team. Following a 25 year career in the British Army, Phil joined London Underground in 2010. He has been involved with a wide array of innovative projects since, and is the Engineering Lead and Chair of the Escalator Passenger Safety Strategy committee.

Kevin Seaborne CEng MIMechE

Kevin Seaborne is a Chartered Engineer of the Institution of Mechanical Engineers. He is the Head of Technical Discipline for Lifts and Escalators for London Underground, accountable for London Underground Lift and Escalator standards and responsible for managing an engineering team which supports all parts of the business. He joined London Underground in 1981 on the Graduate training scheme; having graduated from Sheffield University with a B.Eng (Hons) in Mechanical Engineering. In 1983 he moved into a substantive post in Lifts and Escalators and has undertaken various posts in the intervening period. Notably he was part of the team which delivered over 100 escalators as part of the Jubilee Line Extension.

Kevin is a member of BSI MHE 4 committee and has been a BSI delegate member of CEN TC10/WG2 for escalators works for over 20 years.