Escalator Step Entrapments

David Cooper

University of East London, UK

Keywords: Escalator, moving walk, step-to-step entrapment, comb plate entrapment, step-to-skirt entrapment, prevention, friction, footwear

Abstract. The author of this paper has been engaged in a major research project to reduce the number of entrapments on escalators. Whilst the research covered all types of entrapments, this paper will focus on the types of entrapments that cause life-changing injuries, particularly to young children, including step-to-step entrapment, step-to-skirt entrapment and comb plate entrapments. Injuries include severe crushing and, in some cases, amputation. Examples of real-life accidents will be cited with a focus on methods of prevention. The research has revealed that these types of accidents can be reduced significantly, which has been confirmed by laboratory testing by a major escalator manufacturer.

1 INTRODUCTION

Entrapments on escalators are not a modern phenomenon. Cases can be traced back to the very early days of escalators. The original patent for an escalator was filed in 1859 by Nathan Ames in the USA, but the escalator that we are most familiar with today (2026) is a combination of the designs of Seeburger and Reno that were merged around 1935 when the two organisations were purchased by OTIS. A modern escalator has more safety features than those dating back to then, such as drop step switches, missing step detection, auxiliary brakes and so on, but apart from deflector brushes to keep feet away from the gap between the side of the step and the skirt, little has changed. In fact, the change in step design from wood to cast metal and the change in passenger footwear design from leather to synthetic materials has increased the risk of entrapment due to increased friction.

Three types of entrapment will be looked at in this paper:

1. Side-of-step entrapments
2. Step-to-step entrapments
3. Comb plate entrapments

Some entrapment cases, such as side-of-step entrapment or step-to-step entrapment, may lead to a comb plate entrapment.

Examples of entrapments can be seen below.



Figure 1 Side-of-step entrapment



Figure 2 Step-to-step entrapment that led to a comb plate entrapment

2 HISTORY OF ENTRAPMENTS

A literature search has revealed that the subject matter has been known for at least 56 years, yet entrapments are still occurring.

- 1970: UK Government ran a public information campaign on escalator entrapments on TV [1].
- 1973: Dr Campbell Reid publishes a paper entitled “Escalator injuries of the hand” [2].
- 1982: Carl White published a paper “measuring step clearances and inspection of escalators and moving walks” [3].
- 1984: HSE published PM34 entitled “Safety in the use of escalators” [4].
- 1984: HSE published PM45 entitled “Escalators: Periodic thorough examination” [5].
- 1996: D A Cooper presented a paper at Elevcon in Barcelona entitled “Escalator side of step entrapments” which was published in the trade press [6].
- 1996: B Fowkes presented a further paper at Elevcon in Barcelona entitled “Escalator side of step entrapments” [6].

- 1999: Directorate for Engineering Science in Maryland, USA, met to discuss escalator step-skirt entrapments [7].
- 1999: ASME met to discuss escalator safety, including friction and step clearances [8].
- 1999: Arthur D Little published a report entitled “Escalator step/skirt performance standard” commissioned by NEI [9].
- 1999: After the Arthur D Little report, ASME convened again to discuss the problem [10].

Then research went silent until:

- 2013: CPWR published a report, “Deaths and injuries involving elevators and escalators”, in which they call for the elimination of escalator entrapment hazards [11].

It is clear that the industry has failed to reduce entrapments to an acceptable level.

The phrase "we have known about it for a long time" implies long-standing awareness of a situation, often suggesting that actions or decisions should have been taken sooner. It highlights a gap between knowledge and action, frequently used to express frustration or the necessity of acting on existing information.

But entrapments are still happening at an alarming rate.

A report by TFL cited that there had been 55 foot entrapments on escalators in 12 months, of which 37 were children.

The number of entrapments reduced significantly during the global pandemic, but by 2024, it had nearly risen to pre-pandemic levels.

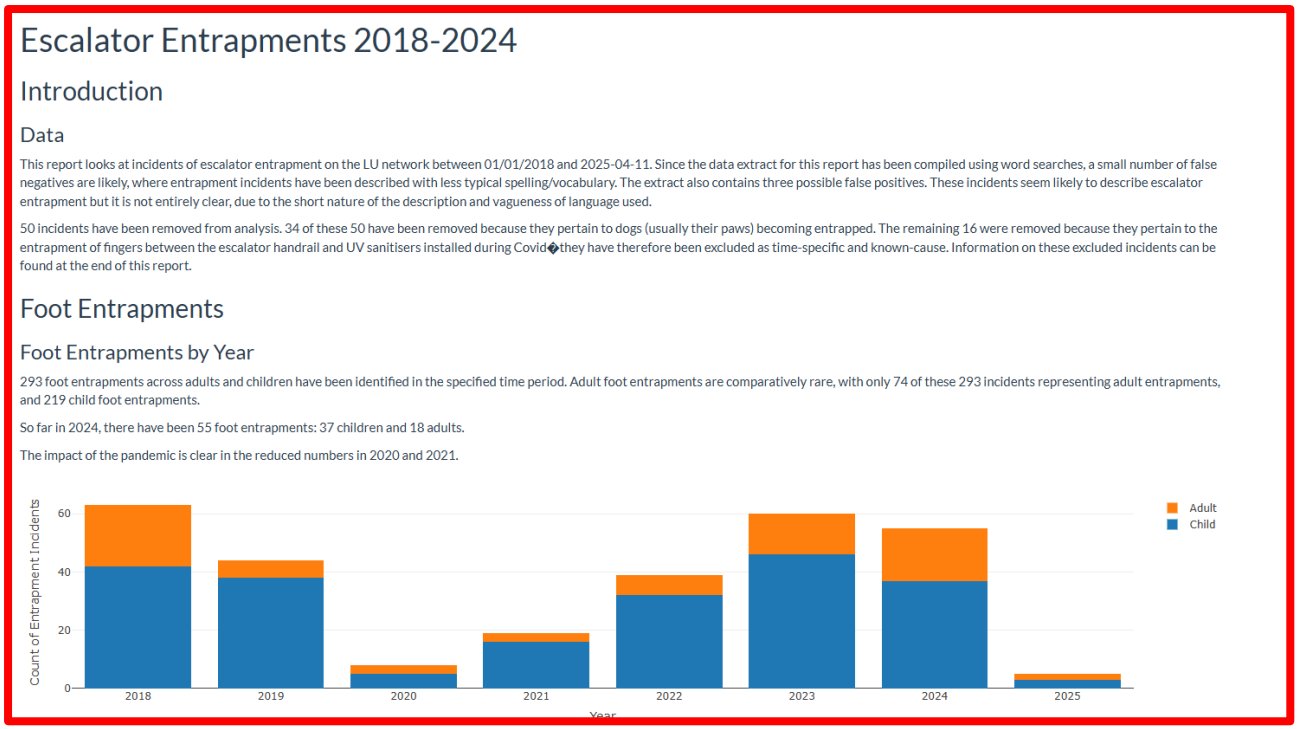


Figure 3 Report by TfL declaring 55 foot entrapments *so far* in 2024 [13]

3 ATTEMPTS TO REDUCE ENTRAPMENTS

Several designs and safety-related ideas have been tried, including:

1. Painting step demarcation lines
2. Raised step demarcation
3. Deflector brushes
4. Application of low friction surface coatings to skirts (not risers)
5. Painting footmarks on steps showing where to stand
6. Education of passengers

Painting step demarcation lines was an early idea which simply involved applying a yellow line around the outside of the step tread to indicate where not to stand. This is a similar approach to painting footprints on a step and is designed to indicate where not to place feet as opposed to where to place feet.

But entrapments still occur.

Raised profile step edges, similarly coloured, have been introduced and are designed to give a tactile indication to the footwear user that feet should not be placed in this area, but accidents still occur.



Figure 4 Side-of-step entrapment with raised step edge profile

Deflector brushes have been fitted as an option since the 1995 EN115 standard. Interestingly, the HSE in the UK issued a letter to the industry saying that, despite deflector brushes being optional in the standard, they expected them to be fitted to all escalators.

Nevertheless, entrapments still happen.

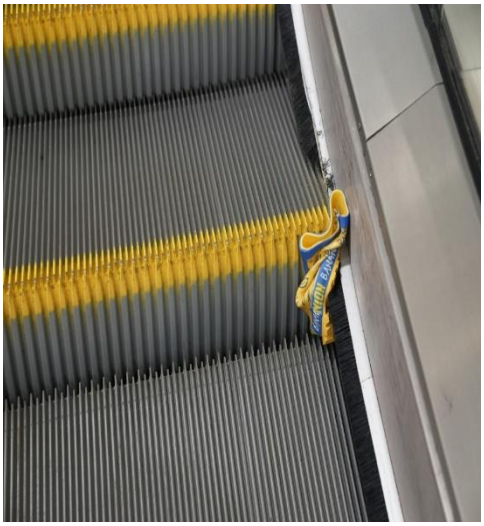


Figure 5 Side-of-step entrapment with deflector brushes fitted

There is research currently being undertaken into the effectiveness of different coloured deflector brushes. Some companies have moved away from the traditional black brush to a combination of red and yellow brushes, with red being used in the transition areas where the risk of entrapment is higher, and yellow on the incline. There is a theory under investigation at present that bright coloured deflector brushes actually attract children to place their feet into a risk zone.

In light of the data, there have been several more recent investigations and reports into escalator safety in general and/or entrapments specifically, including:

- 2024: London Underground published a paper “Guidance for enhanced escalator anti-entrapment features”.
- 2024: TfL published its papers on escalator entrapments 2018-2024, from which the 55 entrapments previously mentioned were cited.
- 2024: Peters Research was commissioned by a major escalator owner to investigate accidents on escalators, including entrapments.
- 2025: LECS (UK) were commissioned by a major escalator owner and prepared a report entitled “Escalator entrapments avoidance”.

4 FURTHER CONSIDERATIONS FOR REDUCTION IN ENTRAPMENTS

Apart from the application of a lubricant to reduce friction, which has been applied to skirt panels and continues to be required as part of some manufacturers’ operating & maintenance manual, little has been done to reduce friction.

There is little the escalator industry can do to affect the shoe wear design market. All that can be done from an escalator industry perspective is to reduce the coefficient of friction at step risers and skirts and to educate passengers.

Reducing the friction at step risers has been researched and tested, and it has been found that the application of low-friction surfaces to step risers significantly reduces the risk of entrapment.



Figure 6 Escalators with low-coefficient step riser panels (which can be advertising or safety signs)

TKE published a report [12] in 2023 following testing of a low-friction application to step risers using a combination of advertising and safety messages on the step risers.

Its key findings were:

- Entrapment is influenced by multiple factors, including escalator geometry, operating conditions, and footwear characteristics.
- Softer footwear significantly increases the likelihood of entrapment, representing a critical variable in risk evaluation.
- Under the defined test conditions, steps equipped with advertisement panels demonstrated a reduced probability of entrapment compared to standard steps.

5 CONCLUSIONS

- Advertisement panels on escalator steps do not increase the risk of shoe entrapment.
- Under controlled test conditions, panels may contribute to a reduction in entrapment probability.
- The overall risk of entrapment for both configurations is considered very low under normal operating conditions.
- All tested configurations comply with applicable safety standards and code requirements.

It is recommended that the LEIA and EESF safety campaigns to educate children [13, 14] be introduced into mainstream curricula and that government public information films be reintroduced.

It is also recommended that reduced friction step riser panels be introduced as standard to all escalators (both new and existing).

The low coefficient of friction panels can be either safety notices, advertising panels or a combination of both. Where advertising panels are used, they can be used as a source of income for the escalator owner to self-fund the safety initiative.

REFERENCES

[1] UK Government ran a public information campaign on escalator entrapments on TV, 1970

[2] Dr Campbell Reid "Escalator Injurious of the hand", 1973

[3] Carl White "Measuring step clearances and inspection of escalators and moving walks", 1982

[4] HSE PM34 "Safety in the use of escalators", 1984

[5] HSE PM45 "Escalators: Periodic thorough examination", 1984

[6] D A Cooper "Escalator side of step entrapments" Elevcon 1996

[7] Directorate for Engineering Science calling notice "Escalator step-skirt entrapments", 1999

[8] ASME calling notice to meeting to discuss escalator safety including friction and step clearances, 1999

[9] Arthur D Little "Escalator step/skirt performance standard" commissioned by NEI, 1999

[10] ASME calling notice post the Arthur D Little report to convene again to discuss the problem, 1999

[11] CPWR "Deaths and injuries involving elevators and escalators", 2013

[12] TKE report "Testing of a low friction application to step risers", 2023

[13] LEIA Safety campaign, https://www.leia.co.uk/safety/liam-loves-safety-campaign/

[14] EESF SafeTRider Safety campaign, https://www.eesf.org/elevatorandescalatorridersafety

BIOGRAPHICAL DETAILS



David Cooper MBE is the CEO of UK based consultants LECS (UK) Ltd and LECS (UAE). He has been in the lift and escalator industry since 1980. He holds a Master of Philosophy Degree following a 5 year research project into accidents on escalators, a Master of Science Degree in Lift Engineering as well as a Bachelor of Science Honours degree, Higher National Certificate and a Continuing Education Certificate in Lift Engineering.

He is the co-author of "The Elevator & Escalator Micropedia" and "Elevator & Escalator Accident Investigation & Litigation" as well as being a contributor to a number of other books including CIBSE Guide D. He is also the founder of the Elevator Academy which provides free training for apprentices and trainees and is a Founding Trustee of the UK's Lift Industry Charity.

In 2012 David was awarded a CIBSE silver medal for services to the Institution, in 2021 he was awarded the Sir Moir Lockhead award for 30 years dedication to safety in the lift & escalator industry and in 2023 he was awarded an MBE for services to lift & escalator engineering.

He is a member of the Society of Vertical Transportation (SovT) Committee. He also serves on the CIBSE Board and is currently President. He is a past Honorary Visiting Professor at The University of Northampton and currently an Honorary Visiting Professor at The University of East London.