

# ESCALATOR SIDE OF STEP ENTRAPMENTS

By

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## 1.0 ABSTRACT

The IAEE Elevcon '90 workshop on escalator safety convened by Bernard James drew attention to entrapment accidents (of all types) on escalators. Despite six years having passed and the awareness of the problem having become more prominent in the public eye, action to remedy the problem of side of step entrapment has not received the attention by owners and operators of both new escalators and older types as perhaps it deserves. Passenger entrapments between the steps of an escalator and the balustrade skirting have been an issue which has been with us for some time. The recent introduction of the new version of EN115 does not call for any devices to minimise the risk. It is considered by the author of this paper that this is a mistake and overlooking such devices will inevitably lead to further injuries. The author will look at the problem giving details of how it arises, the consequences, the exposure, case histories, papers by professionals from within the industry and also medical professionals.

## 2.0 THE PROBLEM

The problem itself is the direct entrapment of limbs or the entrapment of clothing which directly leads to limb entrapment in the gap between the edge of an escalator or moving walkway step and the side wall adjacent to the steps known as the balustrade skirt.

Escalator side of step entrapments are not a new topic within our industry, records dating back to the mid 1960's can be readily found detailing incidents where passenger injuries have occurred as a result of this situation.

Manufacturers deny that there is a serious problem when considering the number of passenger trips made every day however, incidents and reports suggest that even though the number of trips between accidents are low, the actual volume of accidents warrants more attention. Evidence collected over the past few years raise queries on the extent of the problem and also detailed accident records kept by independent authorities such as the DTI helps to clarify the case. Other statistics available are kept by interested parties and manufacturers. The latter do not tend to release the information they have accumulated into the public gaze, probably for obvious commercial reasons. In the USA the problem has been brought to the public attention by various television documentaries and press barrages however, the problem is world wide and is not restricted to the USA or UK alone.

### 3.0 HOW THE PROBLEM OCCURS

There are a number of ways of becoming entrapped in the gap concerned. Some entrapments are of clothing with no limb injury involved but by far the most serious, in terms of injuries, are those where limbs are caught.

It is important to remember that we are only discussing the problem of the gap between the edge of the steps and the balustrade skirting and not any other entrapment points on escalators. Many of these are detailed in Health & Safety Executive releases in the UK.

The most frequent situations where the problem occurs are as follows:

- (1) Loose clothing (including shoe laces) being drawn into the gap and becoming entangled.
- (2) Fingers becoming entrapped when people fall over on the escalator.
- (3) Fingers or feet becoming entrapped when children either deliberately or inadvertently place their fingers/feet at or near the gap.
- (4) Footwear being drawn into the gap as a result of friction.

Other accidents have involved long hair becoming entangled.

The Elevcon '90 workshop focused on situations where loose or long flowing clothing is worn as there is a possibility of it being drawn into the gap. Also, it was reported that draw strings on passengers head-wear and flimsy footwear were a cause for concern.

Reported accidents from category (3) include a case investigated by Dr Campbell Reid where the child had deliberately entered its hand into the gap.

Other incidents have focused on children's footwear, principally wellington boots where the material they are made from has been known to melt as a result of the friction when they rub against escalator side skirt panels and have eventually become stuck to the panel. The escalator step band continues moving thus drawing the child's entrapped foot and footwear into the gap between the step and panel as there is nowhere else for it to go, and no time to remove the foot from the boot as the escalator step band is still moving.

### 4.0 THE CONSEQUENCES

The consequences of entrapment range from a near miss to fatal injuries being sustained. In a paper by Dr Campbell Reid of The Plastic & Jaw Department of The Royal Hospital Annexe in Sheffield, UK a number of cases are discussed where extensive lacerations and damaged tendons have been experienced.

In one incident a young girl was known to have narrowly escaped scalping after her hair became entangled whilst attempting to retrieve a coin which she had dropped on an escalator. This incident was also reported in the local press.

5.0 EXPOSURE TO THE PROBLEM

It is generally agreed that more people use escalators per unit than elevators. The traffic handling capacity of an escalator is far greater than that of an elevator as in theory there is no waiting time for the machine itself. An escalator with maximum step width and running at maximum speed (both as stated in BS5656 / EN115) can carrying up to 13,500 passengers per hour. The statement that more people use escalators than elevators is generally known but the Boston Globe newspaper printed escalator & elevator usage & installation figures for the USA as a whole on 4th August 1995. Naturally, the unit installation figures are more likely to be accurate than passenger usage figures as the latter are both transient and more than likely theoretical rather than measured.

| INSTALLED UNITS & TRIPS<br>MADE IN USA |      |
|----------------------------------------|------|
| Elevators installed:                   | 600K |
| Escalators installed:                  | 30K  |
| Estimated Elevator trips per day       | 55M  |
| Estimated Escalator trips per day      | 180M |
| <i>Source: Boston Globe</i>            |      |

Notes from data:

Ratio of installed elevators to escalators: 20:1

Ratio of escalator trips to elevator trips per day: 3.27:1

Ratio of installed units to trips per day for elevators: 92:1

Ratio of installed units to trips per day for escalators: 6000:1

Obtaining precise figures detailing escalator accidents yet alone specifically side of step entrapments is very difficult. By piecing together pieces of information gained from various reliable sources I have managed to create the following table of accidents in the USA. It should be borne in mind that these figures are for all escalator accidents not just side of step entrapments. Source locations for information used in this table are available from the author.

| Place →<br>Detail ↓                                                  | USA     | Michigan | New York<br>Subway | Washington<br>Metro |
|----------------------------------------------------------------------|---------|----------|--------------------|---------------------|
| Number of installed elevators                                        | 600,000 | 10,700   |                    |                     |
| Number of installed escalators                                       | 30,000  | 670      | 168                | 510                 |
| Total number of accidents involving elevators & escalators per annum | 18,000  | 57       |                    |                     |
| Accidents on escalators per annum                                    | 16,000  | 35       | 199                | 31                  |
| Accidents with elevators per annum                                   | 2,000   | 22       |                    |                     |
| The likelihood of an elevator being involved in an accident          | 300:1   | 486:1    |                    |                     |
| The likelihood of an escalator being involved in an accident         | 1.88:1  | 19:1     | 1:1.18             | 16.5:1              |

Getting down to the specifics of entrapments , a paper published by Carl White in the USA entitled "Escalator Accident Statistics and Safety" compared two maintenance contractors escalator accident figures for the period 1971 - 1977. The figures were obtained from the companies by two methods, one company had voluntarily published the figures and the other had been made to reveal theirs during a court case in a product liability dispute. The figures extrapolated show the statistics for persons being entrapped in escalators whilst on the step chain:

| 1971 - 1977                        |           |           |       |
|------------------------------------|-----------|-----------|-------|
|                                    | Company A | Company B | Total |
| Step/Skirt Accidents (inc. risers) | 391       | 770       | 1161  |
| Combplate Accidents                | 228       | 289       | 517   |

It can be seen that by far the number of accidents involving step/skirt entrapments outweighs the number of combplate entrapments. What is even more worrying is that if you look at the individual year figures for side of step entrapments only the trend is most definitely upwards with only two drops being recorded (and incidentally being consecutive) for Company B between 74/5 & 75/76 and 75/76 & 76/77 being recorded.

| Company | 71/2 | 72/3 | 73/4 | 74/5 | 75/6 | 76/7 |
|---------|------|------|------|------|------|------|
| A       | 32   | 34   | 54   | 79   | 93   | 99   |
| B       | 55   | 59   | 72   | 226  | 213  | 145  |

## 6.0 KNOWLEDGE OF THE PROBLEM OUTSIDE THE INDUSTRY

### 6.1 THE NEWSPAPERS

Since Elevcon '90 newspapers around the World have focused their attentions on the problem. The following cuttings are from accidents which can be related directly to entrapments not just side of step entrapments which are highlighted by an \* by the date. The reason for this is because when they were reported their precise location on the escalator was not recorded:

| Date                    | Newspaper             | Detail                                                                                                                                                                                                        |
|-------------------------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Unknown but after 1990* | Sunderland Local (UK) | Reported that a child had bent down to pick up a coin she had dropped and her hair became entangled down the side of the step in between the step and the skirt. Quick action by passengers avoided scalping. |

|                        |                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|------------------------|----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Unknown but after 1990 | Unknown Woman's National Magazine (UK) | Reported that a three year old Birmingham girl had fallen over whilst getting onto an escalator and her hand had become entrapped in a tiny gap pinning her to the moving metal steps. The report is not specific as to whether the entrapment was down the side of the step or between the steps and the combplate.                                                                                                                                                                                                     |
| 1st April 1993*        | Kent Today (UK)                        | Reported that a 5 year old child fell and its foot became trapped between the steps and the balustrade skirting as the step band deprofiled on the run into the comb plate at the bottom end of the escalator.                                                                                                                                                                                                                                                                                                           |
| 26th July 1993*        | Kent Today (UK)                        | Reported that a three year old boy had his foot dragged between the edge of the step and the skirting as the family were looking at nearby clothing racks in a department store                                                                                                                                                                                                                                                                                                                                          |
| May 1994               | Belfast Telegraph (UK)                 | Reported that a toddler had lost part of a finger as a result of an escalator entrapment. The location of the entrapment was not reported.                                                                                                                                                                                                                                                                                                                                                                               |
| 4th December 1994      | Boston Sunday Globe (USA)              | Published a report announcing that the Washington Metro, USA had had 2 people killed and 150 injured on escalators in the period between 1985 & 1994. Also that a 1991 report stated that there had been 156 injuries in the previous 5 years and 1800 over a period of 15 years. One of the deaths reported in the newspaper was an incident where a 40 year old woman was fatally injured when her clothes became entrapped in an escalator. The precise location of the entrapment on the escalator was not reported. |

The report also listed various accidents including a three year old girl from Long Beach, California whose clothing became entrapped in an escalator and a four year old boy who was seriously hurt when his hand was caught in an escalator, again the precise location of the entrapments were not reported.

|                           |                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------------------|---------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 9th January<br>1995*      | Bradford<br>Telegraph &<br>Argus (UK) | Reported that a red wellington boot being worn by a three year old girl was dragged in towards the gap between the steps and the skirting. Fortunately injury was avoided due to deflector devices being fitted.                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 22nd<br>August 1995       | Boston Sunday<br>Globe (USA)          | Published a report which stated that between July 1992 and June 1994 more than 300 accidents (not just side of step entrapments) had been reported on escalators on the Washington Metro.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 25th<br>September<br>1995 | Michigan Free<br>Press (USA)          | The paper reported that a free press analysis of accidents reported to the State of Michigan between January 1994 and August 1995 revealed 95 involving escalators & elevators, of which 62% were attributed to escalators. It was also reported that the state were responsible for 670 escalators and 10,700 elevators.                                                                                                                                                                                                                                                                                                                                                                  |
| 6th October<br>1995*      | Detroit Free Press<br>(USA)           | The paper reported that in May 1994 a woman missed her step on an escalator in an airport and became entrapped in the gap between the steps and the skirt. Further investigations by the paper revealed that 153 accidents had occurred on escalators and moving stairways at the same airport since January 1991 with 19% of the accidents resulting in a hospitalisation. The split between accidents on escalators and moving walkways was 63% and 37% respectively. The report also stated that the Product Safety Commission had revealed that "Nationally, an estimated 18,000 people per annum are treated in hospital for injuries received whilst using elevators or escalators." |
| 21st<br>November<br>1995* | Newsday (USA)                         | Reported that a three year old girl riding a subway escalator had received crushing injuries to her toes. The paper went on to highlight the lack of entrapment prevention devices on some escalators.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 11th<br>December<br>1995* | Daily Mail (UK)                       | Reported that until the 1980's there were around 40 accidents a year caused by children's fingers or shoes getting caught between the moving steps and balustrade skirts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

## 6.2 THE MEDICAL PROFESSION

The medical profession have also noted the problem. Dr Campbell Reid, a plastic surgeon at The Royal Hospital in Sheffield noted two similar sets of injuries on children where escalators had been involved and published a paper in 1968 entitled "Escalator injuries". Following a third incident he documented his findings in another paper entitled "Escalator injuries of the hand", which was published in The British Journal of Accident Surgery. There had been other papers by medical professionals on escalator accidents published prior to this, notably "A tragic moving staircase mishap" by Dr Kates.

In all of the cases investigated by Dr Campbell Reid the children involved had all been accompanied by a parent. In one of the cases the child entered their hand into the gap between the edge of the step and the balustrade skirt and became trapped when the gap closed up with the injuries being sustained when the hand was forcibly removed. Detailed examination of the escalator revealed that the gap concerned varied considerably along the length of the escalator.

## 6.3 TELEVISION PROGRAMMES

On 23rd October 1995 a programme entitled "A Current Affair" claimed that 10 people had died on escalators in 10 years. The Atlanta subway also claimed that the fitting on anti entrapment devices had cut the number of accidents they had experienced by 2/3.

The following day another programme entitled "American Journal - 39 Steps" stated that since 1990 Government figures showed 29,000 accidents on escalators including 11 deaths.

Another programme (Newsbeat) claimed that there are 18,000 escalator accidents annually and that Twelve Oaks Mall in Michigan had experienced 28 accidents since January 1994 on 6 escalators.

On 29th November 1995 NBC in the USA broadcasted a programme entitled "moving violations". In this programme a nun called sister Theresa, had taken up the cause of investigating side of step entrapments after her nephew had been involved in an incident in 1976. Her investigations revealed figures from the US Federal Government that over 16,000 people a year are sent to hospital due to escalator accidents (not just side of step entrapments), and that the vast majority were children.

The Newsday programme in USA announced on 21st November 1995 that the New York Underground system had experienced a growing number of escalator accidents, figures quoted were as follows:



| YEAR | ACCIDENTS |
|------|-----------|
| 1992 | 172       |
| 1993 | 182       |
| 1994 | 199       |

#### 6.4 THE LEGAL INDUSTRY

The Washington Post published a case on 9th September 1994 where a 3 year old child was awarded a \$15,000 payout following an incident where she sat on an escalator step and her leg became entrapped in the gap between the steps and the side wall. Her leg was torn open leaving a 6" scar. The award was described as "small" by the paper because the jury judged that the parents had failed to supervise the child properly but also concluded that the escalator had not been maintained properly.

The same newspaper also published a case on 2nd November 1994 following a court decision to award \$218,000 following an incident where a 2 year old girl was standing on an escalator and her shoelace became entangled inside the escalator via the step/skirt gap. When she attempted to pull the lace out her hand was drawn into the gap and became mangled.

American law has held that escalator manufacturers and maintenance companies etc, owe a higher or special degree of care and protection to children than adults (Graves -v- May department store, Burdines -v- McConnell etc.) and a duty to take precautions that would not be necessary in the case of adults (Nettrour -v- J.C.Penny)

Generally, every person using an escalator, except children of such tender age that do not understand or appreciate the danger, is bound to exercise reasonable care of his/her own safety (Hendershoot -v- Macy's).

#### 7.0 KNOWLEDGE OF THE PROBLEM WITHIN THE ESCALATOR INDUSTRY

##### 7.1 CONSULTANTS

Following a news broadcast, Dennis Chandler of Continental Hoisting Consultants wrote to NBC on 4th December 1995 and pointed out that the non fitment of devices to prevent side entrapment actually conflicted with the purpose of the ASME 17.1 safety code that is, "to provide for the safety of life and limb, and to promote public welfare"

Leroy Gravatte, a Forensic Engineer who has investigated many escalator entrapment incidents, also wrote to NBC on 14th December 1995 and stated "I am sick of seeing pictures of children with mangled hands or feet, or with limbs sliced open, the result of being caught in what the industry terms "side of step entrapments". Any gap exceeding 1/16" between the moving escalator step and fixed side skirt panel preys on little people and the injuries suffered by adults are just as disturbing.

Carl White has published many papers world-wide on the problem including "Measuring step clearances and inspection of escalators and moving walkways", "Escalator accident statistics and safety" and "Rubber and brush skirt guards". Barry Fowkes of Kleeneze Sealtech has also published a paper in the IAEE journal Elevatori entitled "Brush guards for increased passenger safety on escalators".

## 7.2 MANUFACTURERS

Manufacturers have been aware of the problem for some time.

Even before this maintenance companies and installers have been known to issue technical information sheets to their engineers. A leading manufacturer issued a marketing document in 1983 entitled "Reduce your liability risk" in which the opening sentence states that "skirt panels are easy to install and protect against the second most common cause of escalator accidents - foot entrapment" The document also states "children are frequently involved, and the number of liability suits is growing at an alarming rate". Finally, the document includes a graph showing the number of product liability suits filed in Federal district courts as rising from 1,579 in 1974 to 8,944 in 1982.

## 8.0 CONCLUSION

Based on the evidence gathered for this paper it is my contention that the need for side of step entrapment prevention devices to be called for in all standards, and to be included by all manufactures as standard should be a mandatory requirement. It is also my conclusion that older escalators with no such devices should be retrofitted with a device as a matter of urgency. One accident is one too many, and those that claim that their escalators have been in service for years and have not been involved in an accident should remember that they are really only years closer to having an accident. Insurance companies should refuse to provide cover for third party injury to escalator owners who do not have such devices. Finally, I believe that the authors of EN115 should search their consciences and ask whether they are happy to live with the knowledge that an accident can occur which could cause both mental and physical distress to a person which could be avoided, or at least minimised, by the specification of a device to prevent entrapment. We know about the problem, we have dealt with the problem in the past, we have the technology readily available to deal with the problem - yet we allow new escalators to enter service without entrapment prevention devices. At least if new escalators have them we can look on it as a kind of inoculation and eventually the problem may go away as old escalators are replaced but with our present standards we are not only allowing the problem to grow but promoting the life of the problem. A final thought, some 15 years ago the UK recognised the number of road accidents where people were injured because they weren't wearing seat belts. The UK legislated that seat belts shall be worn. I ask you to look at the statistics.

David Cooper has been in the UK lift & escalator industry since 1980. He is now a Director of Consulting Engineers, LECS (UK) Ltd and is also a Director and Fellow member of The Institute of Incorporated Executive Engineers. He is also member of The IAEE, NAESA and NAVTP. He is a member of The CIBSE lift group committee and The British Standards MHE/4 committee. He has had many papers published in trade journals including Elevator World, Elevatori and Elevation. In 1993 he chaired the workshop on escalators at the Elevcon'93 conference in Vienna.