AN INVESTIGATION INTO ACCIDENTS INVOLVING LUGGAGE TROLLEYS AND/OR SHOPPING CARTS ON ESCALATORS

By

David A Cooper

BSc(Hons), IEng, FRSA, FIIE, FIDiagE, MCIBSE, LCGI

Submission date: 22nd February 2005

A dissertation submitted in partial fulfilment of the requirements of the degree of Master of Science in Lift Engineering at University College Northampton (Faculty of Applied Sciences)

(14,603 words)

LIST OF CONTENTS

(14,603 words)

TERMINOLOGY

In researching this dissertation a number of words/terms have been located which essentially mean the same thing but are used parochially. For ease of reference these terms are detailed in table (1) below:

UK Term	**Alternative**
Passenger Walkway	Autowalk, walkway, trav-o-lator, moving pavement
Lift	Elevator
Trolley	Cart

Table 1: Comparison of UK and alternative terms.

Where these terms have been quoted from documents it is done so verbatim however when the term has been used by the author the terms “cart”, “lift” and “passenger walkway” have been used.

ABSTRACT

The concept of taking a cart onto an escalator is a fairly new one.

A potentially hazardous conflict exists in environments such as airports, train stations and high traffic intensity environments where escalators exist as part of the access/egress infrastructure where luggage and/or accompanied goods also exist.

In some environments there is often a need to move people quickly and easily from one level to another but accompanied by goods of some form be that luggage or purchased shopping goods.

Very often the quantity, weight and/or bulkiness of that luggage necessitates the need for assisted movement such as a cart. A trend has emerged whereby people want to take such assisted means of goods transportation onto an escalator to promote swift movement from one level to another and to reduce the capital cost of additional lifts.

This dissertation brings together the best accident data and knowledge available from the trolley / cart and escalator industries as well as user experiences which have been located in a wide variety of sources.

The main objective of this dissertation is to provide a single point of information on the concept and to make all information available at a single source in order to allow persons involved in the decision making processes of designing multi floor buildings

with the need to move luggage etc from floor to floor to be aware of the issues involved.

It has been discovered that accidents do occur on a regular basis in environments where the practice is permitted despite recognized standards organisations not recommending that it be allowed.

It has also been discovered that there is an issue with data acquisition in that there is no body or organisation that draws together data for accidents on escalators involving carts. Data for incidents involving either of these two components in isolation is available but not on a multi relational basis.

INTRODUCTION

Accidents on escalators are well documented in terms of the number of accidents occurring but this is not so for the detail of how the accident actually occurred and the factors involved.

The same can also be said for accidents involving carts. This data is easy to locate.

As a result of the lack of detail in public records of how accidents occur, finding details of accidents on escalators specifically involving carts in terms of both recording the rate of incidence and the details of such an incident are difficult. Most details have been recorded generally by owners rather than in a statutory format.

In recent years there has been an increase in the number of locations which have promoted the use of carts on escalators, especially airports.

At the same time as architects and building managers/owners have been promoting the practice the escalator industry itself has been vigorously resisting the practice.

This dissertation has three aims:

1. To bring together the widely dispersed data on accidents on escalators involving carts

2. To draw on findings and to question whether a problem actually exists with the carts on escalators by independent critical appraisal of the concept.
3. To provide designers with consolidated evidence and historical data in order that an objective decision can be made as to whether the concept is appropriate in the circumstances of the design and/or environment they are considering.

The use of carts on escalators is generally seen only in intense traffic situations such as airports and railway stations where luggage carts are a common feature and symptomatic of the environment.

One of the prominent issues is the fact that it is known that there has been at least one fatality involving this practice and therefore should the practice be permitted at all.

Given that there has been at least one fatality is this sufficient to warrant banning carts on escalators completely? If the same mentality was applied to all products none of us would be using a car, motorbike, airplane or train given the fact that they are all regularly involved in incidents.

The concept of risk assessment is therefore important.

This dissertation looks at data obtained from airports and railway stations and in particular:

- **AIRPORTS**

- Frankfurt Airport
- London Gatwick Airport
- London Heathrow Airport
- Paris CDG Airport
- Paris Orly Airport
- Amsterdam Schiphol Airport

- **RAILWAY STATIONS**

- London Waterloo Eurostar Railway Terminal
- Ashford International Eurostar Railway Terminal
- Heathrow Express Terminal
- London Underground

The Health & Safety Executive in the UK have advised in writing that they do not intend to undertake further research on escalator safety at this time. Research has revealed that they appointed Loughborough University to undertake a research document *HSE Research document 12/1989 ergonomic aspects of escalators used in retail organisations* in 1989 and that the guidance note *PM34 Safety in the use of Escalators* was revised in 1992 to include the use of shopping trolleys and luggage trolleys on passenger escalators however that guidance note was never published even though it was issued to interested parties for comment.

The major manufacturers of both escalators and carts have been located and contacted. It is interesting to note that the escalator industry has been keen to state

that the concept of carts on escalators is unsafe however, in general, the cart industry has failed to respond to repeated requests for information. As a result most information from the cart manufacturers has been obtained from sales brochures, site visits and web sites.

There are a few notable exceptions to this statement and they are appropriately acknowledged in the appropriate place in this dissertation.

It is also interesting to note the diametrically opposed opinions that escalator owners in similar environments have on the use of carts on escalators. Some are pro the concept and others are very much against it.

METHODOLOGY

The principal methodology behind this dissertation has been as follows:

1. To collect and analyse incident reports from a European airport where a fatal accident had occurred.
2. To collect and analyse media and industry knowledge into such incidents
3. To visit sites and observe passenger activities.
4. To collect data from a number of other airports owned by another major European airport owner who has indicated a wish to gain from the collection of this knowledge
5. To analyse data provided by a major railway station owner following a number of incidents
6. To collect and analyse media and industry knowledge from escalator and cart manufacturers.

For the purposes of (1) i.e. to collect and analyse incident reports from a European airport where a fatal accident had occurred contact was made with a researcher in Germany who had accumulated data on escalator accidents for the purposes of research. The information received was in the German language and had to be translated, this was only undertaken with the reports where specific words such as luggage, trolleys etc were noted given the enormity and cost of translating each and every report.

For the purposes of (2) i.e. to collect and analyse media and industry knowledge into such incidents data was located from the escalator and cart manufacturing industries as well as sourcing press cuttings and official reports, where obtainable, on actual incidents. Research undertaken and data held by reputable bodies such as the UK's Health & Safety Executive, Parliamentary reports as well as other professionals were also been obtained.

For the purposes of (3) i.e. to visit sites and observe passenger activities site visits were undertaken where a number of different locations were visited and observations made of people in various loci. In particular London's Gatwick Airport, London's Eurostar terminal at Waterloo International and also Ashford International Station in Kent were visited. In addition the Tesco retail outlet in Huddersfield, UK where a cart conveyor is utilized was also visited. The concept of cart conveyors is widely accepted in the USA but cost limitations prevented visits to these sites.

For the purposes of (4) i.e. to collect data from a number of other airports owned by another major European airport owner who has indicated a wish to gain from the collection of this knowledge, and as an extension of (3), Glasgow, Stansted and London Heathrow Airports were visited and data provided by the locus owners was analysed.

For the purposes of achieving (5) i.e. to analyse data provided by a major railway station owner following a number of incidents, permission was sought from a solicitor who had issued investigation instructions following an actual incident where injury was sustained by a lady involving a cart on an escalator to use data that had

been disclosed as part that civil legal case. Permission to use the data was granted. In that case the lady that was injured wasn't using the cart herself but was injured by a cart being used by others. The data revealed some extremely interesting statistics and it was probably the most reliable data held by anyone into such incidents. The locations involved were actually designed from the drawing board such that carts were to be part of the access/egress arrangements for the operation concerned and, unlike other cases, weren't simply escalators that were in place and subsequently the decision to allow carts on them was made. In this particular case there was an expert appointed by the locus owners who drew the same conclusions as the expert for the plaintiff as to the suitability of such an operation.

For the purposes of achieving (6), i.e. to collect and analyse media and industry knowledge from escalator and cart manufacturers a number of documents from within the two industries involved were obtained.

LITERATURE REVIEW

Sturgeon (1987) passed comment in an article about using a cart on an escalator at Frankfurt Airport, Germany. The article indicates his caution about the practice and he reported “luggage handlers are few and far between and special carts have been designed to be taken on and off the escalators. Once the undercarriage catches the edges of the steps the load is off the wheels until the next floor is reached. I was unfamiliar with this new breed of cart but my two bags were heavy and I rolled it on and followed it down. A bit of a thrill! The lady behind me had at least twice as many bags as I and her mountainous pile teetered above me during the descent. I was glad to get off” The article clearly indicates the author’s hesitation about the practice!

A year later in 1988 Mr Sturgeon revisited the matter in a column in the same journal. He questioned the practice of taking goods onto an escalator on a cart and the impact that it may have on the integrity of the steps and other components.

This provoked a response which was published in July 1988. L Huberts of the Liftinstituut in Amsterdam responded which detailed how the risk of jamming was dealt with in the Netherlands.

In contrast to the forgoing opinions from the escalator industry a web site was located, www.airlinequality.com, where passengers are invited to make comments about the quality of an airport they have used. A number of passengers had logged their comments promoting the practice of taking carts onto escalators as a good idea.

An interesting piece of data was revealed by Yoder on *www.pumpkinvine.org* which in two adjacent paragraphs captured statements with respect to both escalators and shopping carts:

- "Escalators carry millions of people safely each year. Yet in Boston (USA), 300 people require treatment every year from injuries received whilst riding on escalators (quoting *NBC Dateline: 1995)* Should we therefore eliminate escalators? (*note: the figure stated is for Boston alone*)

- "A trip to the grocery store is routine. Yet in one recent year, shopping cart accidents resulted in 25,000 trips to the emergency room (68 per day), including two deaths. Two thousand children were hospitalized (quoting NBC Today Show) Should we therefore ban shopping carts?

Research revealed that a commercially private document was commissioned by Schiphol Airport in Amsterdam, Holland which was entitled *An analysis of risks involved in using trolleys on escalators*.

Regretfully this document is not in the public domain and could not be reviewed however it is clear by its very existence that someone felt that there was a need for research into incidents on escalators involving carts.

It is also notable that this location is again a transportation environment i.e. an airport. The research undertaken in this dissertation revealed that the majority of

locus owners who allow the use of carts on escalators are such environments and principally airports and railway stations.

In general, retail environments have tended to design their outlets such that carts are used on the level between a store and its car park. Where this has not been possible lifts, ramps, autowalks or cart conveyors have been employed.

In a publication published by the Naval Safety Centre it was revealed that in the USA 23,000 children under the age of 14 are treated annually for injuries related to shopping carts. Regretfully it does not detail statistically where escalators are involved in these incidents however concepts such as loss of balance, overloading etc are introduced which have validity when applied to the combination scenario of carts and escalators that this dissertation is investigating.

In an article published by The Frankfurt Allgemeine Newspaper a fatal accident is reported. This was a case where a young baby was fatally injured at Frankfurt Airport when the baby carrier in which it was being transported was placed on top of baggage which became unstable when placed on an escalator during the step transition phase in the downward direction. This document is of particular interest due to its severity and documentation relative to this incident could only be obtained via the press release itself even though supporting documentation was sought. In reviewing the document one has to be cautious about the fact that it is a press cutting and this could mean that an element of sensationalism exists but one cannot get away from the fact that an incident occurred where goods were being transported on a cart on an escalator and became unstable and the ultimate event was a fatality.

Attempts to contact the author of the article failed and therefore the best information available is the cutting itself but as a result of enquiries a number of accident reports on escalators were received from the same locus.

An article appeared in the US Santa Rosa Sun Newspaper following serious injuries being sustained by a lady after her cart became crabbed between the balustrades of an escalator. Again, being a newspaper cutting, one has to consider whether there is an element of sensationalism involved.

An expert witness report in the case of Sheila Brenda Wroughton v London & Continental Railways following an accident on 5th June 1998 at London Waterloo's Eurostar terminal revealed data for the three stations which allow the practice of carts on escalators. This document was particularly useful as it opens up data accumulated by the escalators owners and is specific as to whether carts are involved or not. It is also useful that the data covers three separate locations. Most interesting was the fact that allowing people to use carts on escalators was part of the original design of the locus and wasn't a concept that was introduced after initial escalator installation as is the case with most of the other environments that had been investigated. As a result of this particular incident the author was prompted to visit the other locations mentioned in the disclosed documents but no substantial differences in the design of the escalators was found. It was discovered that the carts used at the three locations were of the same manufacture.

Wanzl, a leading cart manufacturer, publish a booklet entitled "getting from floor to floor safely" (Wanzl 1999) the opening paragraph states "Trouble free moving from

floor to floor places particular requirements on shopping trolleys and walkway castors and assumes that the customer has the correct information on the correct way to behave on the walkway". It is essential to note that they refer to a walkway/autowalk and not an escalator however some of the concepts of signage requirements due to customer actions and activity are applicable. This caused the author to consider their statements in detail and prompted attempts to find a similar document by the authors relating to the use of carts on escalators. Such a document was not located and criticism has to be leveled at the manufacturers for this given knowledge of accidents occurring. It may of course be that the cart manufacturer is only aware of incidents on autowalks and not escalators but that seems unlikely. From the method of writing within the documents one had to draw the conclusion that the document was prepared in order to assist autowalk owners in mitigating their liability in the event of an incident.

In a paper entitled *"*Legal principles of escalator accidents*"* by Carl J White and published in Elevator World July 1983 he looked at the issue of contributory negligence in escalator accident cases. It is particularly useful to have legal precedents from actual trial cases.

His paper stated that Vol 26 of American Jurisprudence distinguishes between elevators and escalators and partially defines an escalator as:

"unlike elevators, escalators are neither under the immediate control of an attendant nor of the passengers, but while in operation are in constant motion, with the passengers entering and leaving by merely stepping on or off at the terminus. The

nature of the device is such that the typical accident in connection therewith involves either a slip-and-fall situation or becoming caught in the moving parts. Escalator accidents involving the entrapment of bodily intrusions, i.e. fingers, toes, hands, legs and subsequent injury primarily of children are extremely difficult to defend and in some cases virtually indefensible."

In the matter of Otis Elevator Co v Wood, the courts held that "intended use" is but a convenient adaptation of "reasonable forseeability" and that escalator manufacturers and owners could reasonably foresee the possibility of misuse and the accidents that occur.

In contrast, in the matter of Hendershoot v Maceys it was held that "generally, every person using an escalator, except children of such tender age that they do not understand or appreciate the danger, is bound to exercise reasonable care of his own safety and contributory negligence on his part will bar recovery for injuries sustained by him on or in connection with the escalator.

The author of this dissertation is not aware that this has been tested in a cart accident case but one would have to question whether a passenger taking a cart onto an escalator fulfils the contributory negligence requirement!

There are two major manufacturers of devices which carry shopping/luggage carts on a separate conveyor adjacent to an escalator. These are Vermaport and PFlow, both based in the USA. Their sales literature was obtained and the appropriate safety related information utilized. As a result of this the author made contact with

representatives of the two organisations who were particularly helpful including recommending a site visit to a UK installation at Tesco's in Huddersfield, Yorkshire.

In November 1983 the UK's Health & Safety Executive published a document entitled *"*Safety in the use of escalators*"* which was referenced as Guidance Note PM34. This document detailed how accidents can occur on an escalator and relevant information is utilized. In the early 1990's this document was being reviewed for republishing and a draft copy of the revised document has been obtained. Within that document there is a section entitled "The use of shopping trolleys and luggage trolleys on passenger escalators*"* which contained details of issues such as signage, overloading, damaged carts, design etc. Even though this document was never published the information contained in it is thought provoking and it is quoted verbatim in this dissertation.

Research also located a document reference HS(G)84 issued by the Health & Safety Executive entitled "Shopping Trolleys: Safe system of work guidance". In reviewing the contents of this document the author has to be critical of the fact that enquiries revealed that it wasn't a document that was known to the escalator industry and also that in asking for information on cart accidents on escalators the Health & Safety Executive only provided the PM34 document and failed to mention the existence of HS(G)84. Again this document is quoted verbatim in the main body of this dissertation.

Information specifically obtained from real life scenario's includes details of escalator accidents at Frankfurt Airport from 1st January 2001 to 30th June 2001 inclusive,

Gatwick Airport, London escalator reliability and accident details for September 2003 and details of London & Continental Railways Eurostar operation accident details from 20th January 1998 to 16th October 1999 inclusive. The data obtained from these documents was analysed. The data obtained for London Gatwick is somewhat limited to escalator accidents in general however the London & Continental Eurostar and Frankfurt Airport specifically make mention of cart/escalator accidents.

In addition, statistical data re escalator accidents was obtained for Heathrow Express, London Underground, London Stansted Airport, London Heathrow Airport, Paris Orly, Paris Charles de Gaulle and Amsterdam Schiphol Airports.

A minor report entitled *"*Schiphol – Escalators & Travelators*"* which shows details of anti cart methods on escalators was obtained and some of the photographs contained within that document are used. The significance of this document is that a team from another airport visited the site and made comments on their conclusions prior to making anti cart changes at their own airports.

A German guidance note document reference ZH1/484 entitled *"*Richtlinien fur Fahrtreppen and Fahrsteige" (Guidelines for Escalators and Lifts) was obtained, translated and analyzed. Its purpose appears to be similar to the UK's parochial PM34 document previously mentioned.

There are two International standards for assessing system reliability namely "CEI 812 Analysis techniques for system reliability – procedure for failure mode and effects analysis (FMEA)" and "CEI IEC 1025 Fault Tree Analysis (FTA)". The

concepts promoted in these two standards are used in the analysis of data given their International standing and the need for risk assessment.

The various standards for escalators were analyzed for their content with respect to carts. These include "EN115 Manufacturing standard for escalators and passenger walkways", "ASME (American Society of Mechanical Engineers) A17.1-2000", "BS7801 Safe working on escalators and passenger conveyors in use" and "CAN/CSA-B44-94"

The Retail Traders Association of Western Australia issued a document in March 1999 entitled "Shopping trolleys: code of practice for safe management". Within this document there is a specific section on hazard management. There is no specific reference to escalators however there are generic statements made which are of use.

A book entitled "Elevator & Escalator Accident Reconstruction & Litigation" published by the Lawyers & Judges Association in the USA has revealed a complete section on transporting objects on escalators which is particularly useful in drawing together some concepts surrounding the use of carts on escalators.

A number of minor articles in journals were located which draw together data on the subject. From the USA market these include "Injury facts: shopping cart injury" by the National Safe Kids Campaign, "Escalator safety" by the Consumer Product Safety Commission, "Learn escalator safety and we'll reduce those bloodcurdling screams" by Bob Levey in The Washington Post (5th March 1994), "Safety first" by The elevator

& escalator safety foundation, “Trails, Safety and Risk” by John Yoder, “Riding elevators and escalators safely: what parents may not be aware of” by The elevator & escalator safety foundation, “Dangers of escalators” (source unknown), The Straits Times 29th March 1995, The Detroit Free Press 6th October 1995 and also The National Safety Council, Chicago, Illinois.

The UK Parliament issue annual reports into railway safety and a document entitled “Causes of fatal and serious injuries (all railways)” was obtained and analyzed. This document covers the period 1994 to 1995 by fatal accident categories and 1996 to 1997 by cause. Whilst not definitive as to accidents involving carts on escalators it does contain data which specifically mentions escalators.

The UK’s Health & Safety Executive’s operations unit at Bootle, Merseyside were asked to undertake some research into escalator accident statistics and these have been obtained. The research does not specifically mention carts on escalators however the data provides an interesting insight into reportable accidents.

Similarly, in the USA the Campaign to Protect Workers Rights (CPWR) issued a document in 1991 entitled “Deaths and injuries involving elevators or escalators”. Again, the research does not specifically mention carts on escalators however the data provides an interesting insight into reportable accidents.

Dr Gina Barney supplied data from accident investigations she has undertaken on the subject which contain numerical data which is imported into the analysis section of this dissertation. This is undertaken using the two International standards for

assessing system reliability namely “CEI 812 Analysis techniques for system reliability – procedure for failure mode and effects analysis (FMEA)” and “CEI IEC 1025 Fault Tree Analysis (FTA)”.

Finally, two leading manufacturers of escalators Schindler and Thyssen provided documentation detailing the argument against the use of carts on escalators. Schindler support the documentation with a similar statement on their website (www.schindler.com). Another manufacturer, Kone, also make negative reference to the concept of carts on escalators on their website. (www.kone.com).

PRESENTATION AND ANALYSIS OF ACCIDENT DATA

To some the concept of taking a luggage cart onto an escalator is a way of achieving fast passenger flow of high numbers of passengers. Frank Sherwin (2002) reported his views on Frankfurt Airport where the practice is permitted on the www.airlinequality.com website and stated “I’ve never been happy with Frankfurt Airport, except for the trolleys you can take on the escalator with you. Try that anywhere else! M Devor (2003) reported on the same web site “You can take luggage carts on the escalators. Brilliant idea!” S Elch (2003) also supported the practice.

Escalator industry professionals are not as keen on the concept as the airport passengers previously mentioned.

Robert Caporale (2000) reported in Elevator World “Readers are encouraged to look for other means of preventing the overloading and unsafe transportation of baggage on escalators.

William Sturgeon, (1987) also commented on the practice after visiting Frankfurt Airport. He described it as a bit of a thrill but was concerned by the lady who followed him onto the escalator with her trolley load of baggage which he described as “a mountainous pile teetering above him during the descent”

Other evidence gathered from the escalator industry is analysed later in this dissertation however it can be seen that a different opinion on the concept exists between different sectors

To highlight the dangers of carts and escalators the author has first looked at accident data for carts in isolation and then undertaken a similar exercise for escalators.

The data has then been drawn together where it is known that carts have been involved in incidents on escalators.

The concept can be seen in action below

The questions to ask of the above photograph are as follows:

- What would happen to a passenger lower on the escalator if a bag fell off the cart?
- What would happen to the cart operator if the cart came in contact with the sides of the escalator and rotated?
- What would happen to the passengers behind the cart operator if the cart became wedged between the balustrades?

CART ACCIDENTS STATISTICAL DATA

It has been discovered that shopping carts and children have a well documented accident history without the intervention of an escalator! Yoder (c 1997) states:

- "Escalators carry millions of people safely each year. Yet in Boston (USA), 300 people require treatment every year from injuries received whilst riding on escalators (quoting NBC Dateline Nov. 29 1995 TV Programme) Should we therefore eliminate escalators? (*note: the figure stated is for Boston alone*)

- "A trip to the grocery store is routine. Yet in one recent year, shopping cart accidents resulted in 25,000 trips to the emergency room (68 per day), including two deaths. Two thousand children were hospitalized (quoting NBC Today Show, March 20 1996; a study by Dr Gary Smith, Children's Hospital, Columbus, Ohio) Should we therefore, ban shopping carts?

The only data that can be ascertained from the first statement is the number of accidents occurring annually in the Boston area. Without accurate knowledge of the number of escalators installed in that specific area it isn't possible to conclude a rate of accidents per escalator. All that can be said is that the need for emergency treatment in a hospital as a result of an escalator accident every 1.22 days seems very high.

The same conclusion can be drawn from the second statement in that shopping cart incidents in the USA require a person to be taken to hospital every 22.18 minutes. Again, this seems extremely high and enough to warrant further investigation.

In an article by Wanda Walters the article by Yoder is supported with further statistics including:

- 23,000 children aged under 14 are treated annually for shopping cart injuries.
- 60% of these injuries are from falls.
- 74% of injuries are to the head and neck
- 65% of injured children are male.
- 8% of injuries occur when a cart tips over.

The figure of 23,000 children annually can be related as 63 per day. This in turn relates to treatment being required every 22.86 minutes which is not too dissimilar to the figures quoted by Yoder but it does mean that there are apparently no accidents involving people over the age of 14 years. Clearly this is unlikely to be correct and therefore the figures can only be considered indicative that the number of accidents are likely to be higher than stated.

www.securityworld.com reports that an average of 21,600 children ages 5 and under are treated in hospital emergency rooms for injuries associated with shopping carts each year. Compared to Walters data of 23,000 under the age of 14 this focuses down to children aged 5 and under. By applying the same criteria as was applied to

Yoder and Walters this translates to an incident requiring hospitalization at a rate of 59.18 accidents per day or one every 24.33 minutes.

It can be asserted that the rates of incidence reported from these three separate sources are similar.

The US Consumer Product Safety Commission (CPSC) estimated that in recent years there were about 12,800 hospital emergency room treated injuries annually to children 5 years and under associated with shopping carts www.cpsc.gov . Again, applying the same criteria this translates to 35.07 per day or one every 41.06 minutes.

Clearly this data infers that the rate of incidence is not as regular as that stated by the other three sources however it does appear in general terms that there is at least one hospitalization every hour.

It must also be considered that the data has been applied to periods of 24 hours and in reality people generally spend about 50% of their day at home and therefore if one focuses the data down to a daily risk exposure period of say 12 hours the rate of incidence doubles i.e.:

- Data for Yoder becomes an incident every 11.09 minutes
- Data from Walters becomes an incident every 11.43 minutes
- Data from www.securityworld.com becomes an incident every 12.17 minutes

- Data from The US Consumer Product Safety Commission (CPSC) becomes an incident every 20.53 minutes

Clearly the figures located for incidents involving carts in isolation (with no escalator involved) are high.

The National Safe Kids campaign appears to repeat the data from Walters article but cites further information including:

- Since 1985 at least 5 children have died from shopping cart accidents.
- Of children injured from falls from carts 5% require hospitalization

The previous data from Yoder, Walters and The US Consumer Product Safety Commission (CPSC) do not mention fatalities and this does infer that fatalities do occur but not on a regular basis.

The National Safe Kids Campaign has also established the fact that the number of children ages 5 and under injured in shopping cart related injuries has increased more than 30% since 1985. It is not within the scope of this dissertation to question why there has been an increase in incidents.

www.securityworld.com also reports that shopping carts have a high centre of gravity and a narrow wheelbase, making them top heavy when loaded and therefore easy to tip over. It also states that an average of 5% of children who fall from carts require hospitalization.

The fact that carts become top heavy when loaded is a matter that will be discussed specifically within the carts on escalators section of this dissertation.

The Brain Injury Association of Oklahoma report on their web site that emergency staff are seeing 1 or 2 cases of shopping cart accidents per week in the children's hospital in Columbus.

It is unknown how many hospitals there are in the USA however had this information been known one would have been able to identify if there were particular states where the rate of incidence where high. At present one can only make wide ranging statements about the situation but nevertheless the number of incidents occurring seems far too high to be accepted as comfortable although the inverse argument will no doubt be the ratio of the number of people using trolleys to the number of accidents that are happening. That will, of course, be of little comfort to the families of and the people involved in the incidents, especially the fatalities.

The Retail Traders Association of Western Australia issued a document in March 1999 entitled "Shopping trolleys: code of practice for safe management". Within this document there is a specific section on hazard management. There is no specific reference to escalators however there are generic statements made which can be applied:

9.1 To assist all parties in maintaining a hazard free workplace, the following procedure should apply:

(a) identify hazards in the workplace which may cause injury or disease.

(b) Assess the associated risks to determine the likelihood and consequences of injury and disease

(c) Implement control measures to eliminate or minimize the risk; and

(d) Review and evaluate effectiveness of control measures put in place.

9.2 Effective hazard management includes the following:

(a) keeping adequate records of accidents and near misses

(b) consulting with employees

(c) observations of the way tasks are performed, and

(d) investigating accidents to determine causes.

It is worth noting that even thought clause 9.2(a) states that adequate records of accidents and near misses should be recorded no trace of any records of an accident involving a cart and an escalator in Australia was located however that may well be as a result of poor data gathering rather than the fact that there are no incidents. In addition it may well be as a result of the document being advisory and not statutory.

These wide ranging statements appear to be similar to UK legislation with respect to undertaking risk assessments and managing the risks identified.

METHODS OF PREVENTING CARTS ACCESSING ESCALATORS

A number of owners have banned the use completely and have undertaken measures to prevent access. At London's Gatwick Airport (North Terminal) yellow poles have been fitted immediately in front of the newel posts.

It is of course a matter for debate as to whether the installation of the yellow pole presents other risks that need to be assessed.

The owners of the railway station at Gatwick Airport have installed a similar policy on access prevention however they have adopted a more aesthetically pleasing stainless steel chicane design.

Schiphol Airport, Amsterdam have also undertaken a similar exercise as the railway station at Gatwick.

Whilst the bollards are intended to prevent carts being loaded onto an escalator it is interesting to note that children can often be seen using a bollard as a seat in order to be able to play with the moving escalators handrail! Again, it is a matter for debate as to whether the provision of these bollards presents other risks.

ESCALATOR ACCIDENTS STATISTICAL DATA

The Health & Safety Executive information centre advises “there is no accident data available for incidents on escalators involving trolleys as it is not reportable under RIDDOR” however, they supplied statistics tabulated in table 2 below for injuries involving lifts/escalators as reported to the HSE and local authorities 1991/2 to 1997/8 inclusive:

Severity	91/2	92/3	93/4	94/5	95/6	96/7	97/8
Fatal	1	3	0	1	0	0	0
Major	50	39	33	34	41	105	9
Over 3 day	88	58	57	49	61	43	19

Table 2: HSE detailed statistics for lift/escalator accidents reported by local authorities 1991/2 – 1997/8 inclusive.

.

Source: HSE, Operations Unit, Daniel House, Trinity Rd, Bootle, L20 7HE

This equates to incidents as tabled in table 3 below:

Year	91/2	92/3	93/4	94/5	95/6	96/7	97/8
Total	139	100	90	84	102	148	28

Table 3: HSE accumulative statistics for lift/escalator accidents reported by local authorities 1991/2 – 1997/8 inclusive.

It is significant to note the trend from 1991/2 to 1994/5 where the number of accidents reduced year on year. It is worrying to see the alarming rise again in 1995/6 to 1996/7 but then there was a very significant drop in 1997/8.

The 1997/8 reduction may be as a result of the introduction of the European Standard for the manufacture of escalators (EN115) which was introduced in 1995.

Bearing in mind that we are only dealing with incidents that required reporting it is worth noting that in the UK reportable accidents as detailed in table 4 below occurred at the rate of:

Year	**Rate of incidents**
1991/2	1 accident every 2.63 days
1992/3	1 accident every 3.65 days
1993/4	1 accident every 4.06 days
1994/5	1 accident every 4.35 days
1995/6	1 accident every 3.58 days
1996/7	1 accident every 2.47 days
1997/8	1 accident every 13.04 days

Table 4: HSE rate of accumulative accidents for lifts & escalators reported by local authorities 1991/2 – 1997/8 inclusive.

The dramatic change in rate stated for 1997/8 cannot be accounted for other than maybe the rate of incidents did fall or, as previously stated, the effect of the introduction of EN115:1995. It is not stated on the document that the methodology associated with data capture has changed which one would have expected had this been the case.

More specifically, In October 1987 the HSE commissioned a report from The Institute for Consumer Ergonomics based at Loughborough University in the UK entitled "ergonomic aspects of escalators used in retail organisations".

Phase 1 of that report focused on the collection of data on escalator accidents and incidents. They made a total number of 24,326 passenger observations using the baggage program.

Appendix iii of the report defines the definition of baggage in the programme which includes the following categories:

- Papoose/rucksack
- Non-wheeled child carrying equipment
- Wheeled child carrying equipment
- Shopping trolley
- Walking aid
- Shopping bag
- Child on feet
- Child in arms

- Child in carrying equipment

They reported that of those observations 115 people had wheeled child carrying equipment with them and 45 people had shopping trolleys or wheeled bags.

The study was undertaken in a standard retail environment where carts are not permitted to be used on escalators. It can therefore be ascertained from this data acquisition that 160 / 24,326 people ignored the signage that was in place or less than ½ %. The fact that a higher percentage of those were wheeled child carrying devices is of concern. One has to question how many people disregard the safety signage on escalators. Clearly in this case there is tangible evidence that in 160 cases this was so. The situation with the other passengers who used the escalators cannot be stated either way.

The UK Parliament publish a report annually entitled “causes of fatal and serious injuries (all railways)”. The report of 1995/6 reports 1,729 accidents ascending/descending steps or escalators, 1996/7 1,113 and 1997/8 1,178.

This equates to incidents tabulated below in table 5 as follows:

Year	**Rate of incidents**
1995/6	4.74 accidents every day
1996/7	3.05 accidents every day
1997/8	3.23 accidents every day

Table 5: Published UK Parliament railway location accident rate for steps & escalators 1995/6 – 1997/8 inclusive.

It is interesting to note that if you compare 1995/6 and 1996/7 the railway was probably the location of approximately a third of all reportable escalator accidents. Again, 1997/8 of the HSE reportable accident data appears to have erroneous data and should not be compared with this criteria.

It should again be borne in mind that these were reported accidents and do not take into consideration those that occurred and went unreported and also near misses.

It is unfortunate that one cannot disseminate between the accidents which occurred on escalators and those on stairways.

The US Consumer Product Safety Commission (CPSC) estimates that about 20% of all hospital emergency room treated injuries are from escalators.

The pediatrics journal of the USA published a paper by Platt, Fine & Foltin in 1997 entitled “Escalator related injuries in Children”.

The study looked at all children less than 18 years old who were admitted to hospital in New York between August 1990 and February 1995. A summary of the results is as follows:

- 26 children received escalator related injuries

- The age range was 2 to 16 years old with the average being 6 years old.
- 69% of those injured were accompanied by an adult
- 31% were injured due to misusing the escalator
- 23% were injured while stepping off the escalator
- 50% of the children were admitted to hospital
- The average hospitalization period was 13 days.
- 46% sustained permanent cosmetic deformities.

The conclusion drawn in the paper was that children are at risk of sustaining severe injuries on escalators.

The study covered approximately 1672 days which means that there was an incident resulting in a visit to a New York hospital every 64 days. Given that this is just one state and making the assumption that this is typical of American states it would equate to a hospitalization of a child under 16 years old every 1.29 days throughout the USA.

Bearing in mind that this study was only of children under 16 years old the rate of incidence is not too dissimilar between the UK and the USA if one compares this to the previous HSE statistics.

The Detroit Free Press undertook a statewide accident analysis for escalators. This analysis did not include the City of Detroit itself which fell under different reporting requirements. Hightpower (date n.k) reported in the period Jan 1994 to August 1995 the following shopping mall accidents involving escalators had been reported:

- Oakland Mall 20 accidents
- Fairline Mall 2 accidents
- Twelve Oaks Mall 28 accidents
- Eastland Mall 3 accidents
- Northland 1 accident
- Lakeside 1 accident
- Westland 2 accidents

The total of 57 accidents over 608 days or 1 every 10.67 days.

Again, this seems to be high but when compared to the HSE data it is not too dissimilar to the 1997/8 rate reported in the UK.

It is known that one of the accidents at Twelve Oaks included a lady who took her husband on the escalator in his wheelchair which subsequently tipped over during flight.

The Center to Protect Workers Rights (CPWR) reported in a document entitled "deaths and injuries involving elevators or escalators" (July 2001) (page 111) that "incidents involving elevators and escalators kill about 30 and seriously injure about 17,100 people each year (quoting the US Bureau of Labor).

In addition the CPWR report states “The census of fatal occupational injuries reported 152 deaths in the 7 years 1992-1998 inclusive related to elevators and escalators. 44 of those killed were elevator or escalator passengers.

Unfortunately the ratio of elevator to escalator incidents cannot be disseminated from this data.

An accident reported in the Solihull News (1993) that was located involving baggage on as escalator was at a store in Solihull, UK on 14th April 1993. A man laden with bags fell down an escalator and died following the spurious operation of the emergency stop button. Whilst a cart was not involved it does demonstrate the major injuries that can be sustained by falls on escalators.

It is significant to note that the Detroit Free Press ran an article on 25th September 1995 which was headlined “DANGER OF ESCALATORS: Reporting of accidents falls short of state law”. It highlights one of the problems that is of concern and can be summed up by the first paragraph which states “Escalator and elevator accidents across Michigan routinely go unreported. We often don’t find out about it until long after the fact,” said Thomas Riddering, Detroit’s chief engineer and chairman of the states elevator safety board”.

In a document obtained from BAA for the reporting period 2002/3 the following actual accidents were recorded and tabulated below in table 6:

Location	No of Accidents	Reportable Accidents	PAX	No of Escalators
Edinburgh Airport	1	0	7,072,448	3
Gatwick Airport	94	13	29,641,806	43
Heathrow Airport	72	3	62,954,648	70
Stansted Airport	33	0	16,745,624	47
Heathrow Express Terminal	19	n/a	5,044,145	9
London Underground Ltd	616	n/a	1,000,000,000	408
Paris CDG	17	n/a	48,296,581	90
Paris Orly	2	n/a	23,150,466	78

Table 6: British Airways Authority accident rates for escalators 2003/3.

SUMMARY OF COMBINATION OF CART AND ESCALATOR ACCIDENT STATISTICS

Given the data which has been located for shopping/luggage cart accidents and escalator accidents in isolation research was then undertaken into what actual incidents had occurred on escalators where carts had been involved.

Contact was made with the sales manager of a company that manufactures a cart conveyor in the USA. His response was “The accidents we hear about occur when one tries to move trolleys on an escalator. These are common and usually eventful. Our product, in essence, offers an alternative to this unsafe practice”.

Clearly there is a commercial slant to this response however the incidents located during research demonstrate that “eventful” is an apt description of such incidents.

ACTUAL INCIDENTS AT LOCATIONS WHERE THE USE OF CARTS ON ESCALATORS IS PERMITTED

EUROSTAR RAILWAY TERMINALS

London & Continental Railways, who operate the Eurostar terminals in London, Ashford, Lille, Brussels and Paris promote the use of carts on escalators.

They have revealed data for the three stations which allow the practice of trolleys on escalators due to legal disclosure.

Data has been obtained for the period between 20th January 1998 and 16th October 1999.

As this was obtained as a result of a legal case against the location owners, the plaintiff's solicitors were contacted and have given permission for this data to be referenced.

The data disclosed that there were 59 accidents on escalators and 13 of those involved incidents with carts.

This equates to an escalator accident every 10.74 days. This is remarkably similar to the American shopping malls looked at previously where there was a total of 57 accidents over 608 days or 1 every 10.67 days.

This also equates to a 14 cart related accidents in 634 days i.e. 1 incident every 45.28 days involving carts. The incidents were distributed across three stations on the following dates:

- Waterloo: 15/4/1998, 22/5/1998, 5/6/1998, 21/1/1999
- Ashford: 23/3/1998, 20/5/1998, 24/5/1998, 24/6/1998, 30/8/1998 27/9/1998, 29/9/1998, 15/2/1999, 14/7/1999
- Brussels 14/9/1998

If one looks at the data above it can be seen that Ashford Station by far has the worst Accident record. In the 634 day period the distribution was as follows:

- Waterloo 4 accidents
- Ashford 9 accidents
- Brussels 1 accident

I could find no reason on my visit to Ashford Station as to why the rate of incident was higher there than at Waterloo. This leads me to believe that the data should be regarded as general however I would have welcomed the opportunity to analyse data accumulated post 16th October 1999.

Dr Gina Barney, a recognized expert in escalator safety, advised (2003) that she had cause to review a passenger transportation environment and was advised that in 7,000,000 passenger movements in a period of 1 year she had located 3

hospitalizations and 10 other incidents involving carts on escalators. This can be equated as 13 accidents in 365 days i.e. 1 incident every 28.08 days. In general her findings are not dissimilar to the data I noted with respect to the Eurostar terminals.

The procedure generally used for risk assessment in the vertical transportation industry is that given in ISO/PDTR 14798-1, which comprises five stages:

- Hazard identification
- Risk analysis
- Risk reduction
- Risk control
- Documentation

In the case of the incident at London Waterloo Eurostar Railway Station two experts representing opposite sides in the case had inspected the locus.

The hazard has already been identified in that it is acknowledged that passengers are at risk when mixed with baggage trolleys on an escalator.

The risk analysis looks at the severity of an accident and its frequency. An expert involved in the investigation classified the risks as class II and class III i.e. severe injury and minor injury. It was reported that class I i.e. death and class IV i.e. no injury, were unlikely.

The term unlikely should be noted as it does not rule out entirely the possibility of a fatality.

The frequency of an incident was recorded from physical data i.e.:

3 x class III injuries requiring hospital attendance and 10/12 class III injuries not requiring hospital attendance for some 7,000,000 passengers in the period measured. It was determined that this should be classified as Class A frequency i.e. likely to happen often.

The risk assessment profile was therefore determined as IIIA and is considered unacceptable by experts.

FRANKFURT AIRPORT

Frankfurt Airport in Germany is another location where the use of carts on escalators is permitted.

A number of reported incidents have been located at this venue including, regretfully, one fatality.

The Frankfurt Allgemeine Newspaper reported (1997) "….A few weeks ago a tragic accident involving a baby caused uproar. The parents placed the baby in a carrier on top of bags on the trolley (cart). They were travelling in a downward direction when the bags tilted forward and the baby carrier fell off the bags and down the escalator. The baby died in hospital……."

With the benefit of hindsight one may well argue that the accident was entirely foreseeable however it must be argued that it cannot be an obvious risk for parents to present their child to such a risk without due consideration.

One must be conscious of the fact that this is a press report and that there may be some sensationalism involved.

It was further reported (ibid) that:

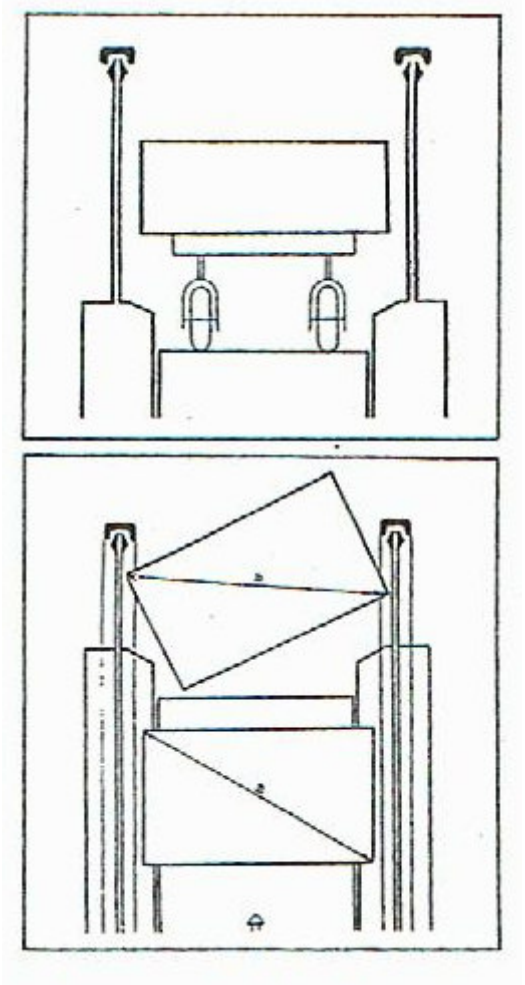
"….An employee of Zagreb airport reported that during a stop in Frankfurt's Airport….she was travelling up an escalator when a passenger pushing a trolley in

front of her got caught in the upper landing due to misuse of the brake. Congestion built up and the Zagreb airport employee tried to exit the escalator over the balustrade. She was badly hurt……"

It should be noted that the accidents reported here have occurred with escalators travelling in both the up and down direction. The situation with escaping over the balustrade can be regarded as a similar incident previously described which occurred at Waterloo Eurostar terminal on 5th June 1998.

In another incident at Frankfurt Airport serious injury was sustained by a passenger. The Santa Rosa Sun Newspaper reported (1993) "…About three-fourths of the way down, somehow, the cart became lodged between the sides of the escalator, now in a sideways position to the steps. Only, when it became jammed and the steps continued to move, the cart no longer rested on the steps but became elevated above the steps. And since the cart became stationary, and the steps with the passengers continued to move, the male became jammed under the cart and his wife under him. And all this time, the steps continued to move, unmercifully beating the side and back of her body…."

This incident involved the luggage cart becoming crabbed however experience from Holland (Huberts, 1988) shows that it may simply be the luggage being conveyed that gets entrapped as can be seen in the following diagram:



Drawing produced from letter entitled "unintended usage" published in Elevator World July 1988.

The Frankfurt Allgemeine Newspaper article (1997) also reported that Frankfurt Airport presented a number of reasons why incidents occur but in the same article it was claimed that in 1996 nearly 39,000,000 passengers used the airport and approximately 2 in 5 used trolleys (carts) on the escalators. It is admitted that there were 55 incidents directly attributed to trolleys (carts) on escalators in that year. This equates to one trolley (cart)/escalator incident every 6.6 days.

Again looking at data from the scenario reported by Dr Barney it can be seen that the rate of incident is higher (1 every 6.6 days compared to 1 every 28.08 days) however the Frankfurt Data reports 39,000,000 passengers in that year and Dr Barneys scenario 7,000,000; a ratio of 39 to 7 or 1 to 5.57. If one multiplies the Frankfurt incident rate of 1 every 6.6 days by the passenger ratio of 1 to 5.57 it can be extrapolated to a cart incident every 36.72 days which, again, is not too dissimilar to 28.08 days. In general one could say that an incident can be expected on average about every month or that 1 (passenger) in 709,090 would be injured with a cart on an escalator at Frankfurt and 1 in 538,461 at Eurostar sites.

As previously stated, The Frankfurt Allgemeine Newspaper (1997), presented a number of reasons why incidents occur:

- Overloading of trolleys
- Pushing the trolleys with only one hand causing them to tilt
- Pulling trolleys from behind rather than pushing
- Not leaving enough distance between users on the escalator
- Placing children on the trolleys

ACCIDENTS AT DETROIT AND LONDON GATWICK AIRPORTS

The Detroit Free Press (1995) stated “because of the presence of luggage, airport escalators and moving walks pose risks even to the safest of riders. At least 16% of the airports 153 accidents since 1991 were caused in part by peoples luggage or luggage carts, the free press found. In some cases, the luggage became caught in the machinery and luggage carts wedged against the side walls, causing people to trip and fall. In other cases, luggage and carts fell down escalators, starting a domino effect over the people in their path.”

One can only take a general view of this data but it appears that in the 4 years from 1991 to 1995 (and in reality is slightly less than that because the article appeared in October) an escalator accident occurred every 9.54 days. If 16% can be attributed to luggage or luggage carts this equates to a luggage related incident every 58 days.

In an investigation by BAA for the 2002/3 period it was revealed that 26% of all BAA passenger accidents involved escalators, a total of 560 incidents.

23% of those incidents were luggage related and 12% as a result of misuse including taking carts onto escalators.

BAA took the decision, along with Amsterdam’s Schiphol Airport to prevent carts being taken onto escalators.

This policy has also been adopted by the UK operator of railway stations, Network Rail, and in particular at Gatwick airport station.

The report also noted that Frankfurt Airport have reduced their escalator speeds from 0.5 m/s to 0.35 m/s and reported a positive result. This is interesting and was not mentioned in any of the Frankfurt Airport data obtained.

It may well prove useful if a study of the angle of inclination of the escalators involved in reported accidents were undertaken as this information is unavailable at the time of publishing but there may well be some correlation between 30° and 35° installations.

WHAT DOES THE ESCALATOR INDUSTRY SAY ABOUT CARTS ON ESCALATORS?

Leading escalator manufacturers make various statements on the concept of carts on escalators.

Schindler state on their website (2004) *"*Because it is dangerous to bring wheeled vehicles or bulky packages onto escalators, signs should be posted alerting passengers where to find alternative elevator transportation"

The UK office of Schindler also supported this information in a letter (2000) which states "As far as Schindler in the UK are concerned this would be a first (proposal to take carts on escalators) as there has always been a doubt about safety from our customers"

Thyssen, another leading manufacturer of escalators, also advised in a letter (2000) "In real terms passenger trolleys should not be used on escalators, as apart from the health and safety angle the trolleys are likely to cause damage to the step comb plates and other parts of the escalators. We would therefore recommend that passenger conveyors are installed which are manufactured for moving people and trolleys".

Kone, another leading manufacturer, state on their website (2004) "Baby carriages, strollers, shopping carts and wheelchairs are safer transported using elevators"

Another manufacturer, Otis, refused to comment when asked on the matter.

In Elevator & Escalator Accident Reconstruction and Litigation (2002, p 120), a complete section is dedicated to the dangers of transporting objects on escalators. The section states:

"The transportation of wheelchairs, baby strollers, freight and other bulky or heavy objects on escalators has resulted in trips and falls. If the object somehow becomes stationary between the entrance and exit points (caught in the comb plate for example) then the other persons riding the escalator are subsequently forced into that object by the moving steps with predictable results.
As indicated above, the code required caution sign states in part PASSENGERS ONLY. This cautionary note is intended to warn riders not to bring these types of objects on the escalator. However, one only has to go to any mall to see parents taking baby strollers on escalators, or an airport to see luggage carts transported on escalators. The code required caution does not appear to be effective. Apparently, it is too vague, not understood or ignored. Also, in most cases signs are not provided near escalators directing passengers to an elevator as an alternative means of vertical transportation, thereby contributing to the problem.
As noted above, a proposal is being considered that would add a symbol or text, or both, to discourage the transportation of wheeled vehicles on escalators. CAN/CSA B44 already requires this symbol in Canada"

Source: Charles Buckman

The above photograph appears on Charles Buckmans website with the caption "Don't even think about it!!! It will cause a lot of injuries if it jams. Everyone behind them will fall or become jammed too. A woman in an airport in the US lost a lot of skin when this happened at the top of an escalator. She was lucky!"

Again, the questions to ask of the above photograph are as follows:

- What would happen to a passenger lower on the escalator if a bag fell off the cart?
- What would happen to the cart operator if the cart came in contact with the sides of the escalator and rotated?
- What would happen to the passengers behind the cart operator if the cart became wedged between the balustrades?

The elevator & escalator safety foundation were quoted in the Detroit Free Press (1995) as saying “Do not take strollers, baggage carts or wheelchairs onto escalators”. On their web site their views are expanded and they state “Have you ever seen anyone pushing a baby stroller, luggage or a shopping cart on an escalator? Do you know what could happen? The stroller could fall or the child could fall out and be seriously injured. It is much safer for you and your child if you take the elevator. Also, maneuvering strollers, carts or even large packages can prevent you from holding the handrail or it can cause a back-up that is potentially unsafe to other passengers, causing them to fall if the stroller, luggage or shopping cart gets stuck between the sides. It is much safer for everyone if you take the elevator when you’re using strollers, luggage, shopping carts or are overloaded with packages”.

The following photograph emphasizes the point:

Imagine the injuries that child could sustain if it were to fall forward!

(14,603 words)

WHAT DOES THE CART INDUSTRY SAY ABOUT CARTS ON ESCALATORS?

Cart manufacturer, Wanzl, issued a press release in June 2000 which states *"*A special feature of the euro-sprinter is that is can also be taken onto escalators. It is a safe, easy to use luggage trolley that accompanies passengers smoothly through airport controls, no matter how many levels they have to negotiate" (Wanzl 2000b)

On 4th October 2003 a letter was sent to the Managing Director of Wanzl Ltd inviting them to take part in this research, no reply was received.

By reference to Wanzl product brochures (Wanzl 2000a) it is noted that the safe working load of a cart is derated when used on escalators and autowalks.

Whilst this dissertation is not concerned with autowalks is useful to note the derating as tabulated in table 7 overleaf:

Model	Usual SWL	Derated Load	% SWL Reduction
Voyager 2000	250 kg	120 kg on 12 degree autowalk	52%
Type 3B	250 kg	120 kg on 12 degree autowalk	52%
Euro Sprinter	200 kg	80 kg on 30 degree escalator	60%
Traveller 2B	200 kg	120 kg on 12 degree autowalk	40%
Airport Shopper "ES"	80 kg	No mention of SWL on escalator/autowalk.	n/a

Table 7:Wanzl cart manufacturers data for range of manufactured carts (Wanzl 2000a)

Concerns must be expressed over this derating policy as:

- It should be pointed out that the euro-sprinter is limited to 80 kg on a 30 degree escalator however on the approach to the escalator a load of 200 kg is allowed and on the escalator 80 kg – will a passenger know this?

- Will a customer know what their luggage actually weighs?

- What happens if the escalator is a 35 degree type, will the customer know?

Wanzl publish a booklet entitled “Walkway know how: getting from floor to floor safely”, (Wanzl 1999) It should be emphasized that this booklet is specific to walkways and not escalators however it states that three criteria should be met for the safe use of carts on walkways.

The three criteria are:

1. The walkway installation set up must meet the requirements of European Norm EN115.
2. The speed must not exceed 0.5 m/s
3. The cam inclination when pushing the trolley on and off the walkway must not exceed 15 degrees”

- Again, concern with these statements must be registered in that it is stated that the speed should not exceed 0.5 m/s yet a 30 degree escalator is permitted by the EN115 standard of a speed of 0.75 m/s some 50% higher. It seems paradoxical to restrict the use of carts on walkways to 0.5 m/s but permit them on escalators where the speed can be greater and also the transition profiling of the steps into and out of the flat have to be negotiated.

On 4th October 2003 a letter was sent to the Managing Director of Caddie Products inviting them to take part in this research but again no reply was received.

Caddie did however supply a brochure (ref 94) in which there are no carts for use on escalators only autowalks. It is believed that Caddie do not make a product for escalators.

WHAT DO OTHER PROFESSIONAL ORGANISATIONS SAY ABOUT CARTS ON ESCALATORS?

General statements by professional organisations have been located including:

The Elevator Escalator Safety Foundation advise “no canes, walkers or wheeled vehicles on escalators”

.

The US Consumer Product Safety Commission (CPSC) advise “do not bring children onto escalators in strollers, walkers or carts”.

The US Division of Labor and Industry advises “no carts or strollers on escalators”.

The lift industry organisation of New Zealand advises “Do not take pushchairs/prams or shopping carts onto escalators unless they are specifically designed for this purpose”.

The Massachusetts Government states “Do not bring a stroller, carts or large packages on escalators. Strollers do not belong on an escalator. Unsuspecting parents can easily lose an unfastened child in a stroller down an escalator before they realize the hazard exists. Most locations have nearby elevators, if you have a baby stroller, carts or large packages, use the elevator”

The National Safety Council published a data sheet ref 1-516 Rev. 91 which states “a package, stroller or other conveyance placed on the escalator; it may jam between the balustrades or slip from the grasp of the person trying to hold it”. The data sheet goes onto state “where strollers or shopping carts are provided by a sales establishment, mount a sign on the frame of each vehicle so that it faces the passenger and prominently displays its message – DO NOT TAKE STROLLERS / SHOPPING CARTS ON THE ESCALATOR”

CLAUSES IN NATIONAL AND INTERNATIONAL STANDARDS, OTHER GUIDANCE NOTES WITH RESPECT TO THE USE OF CARTS ON ESCALATORS

- The ASME 17.1 standard clause 6.1.6.9.1 states: “The (caution) sign shall include the following wording…(a) caution (b) passengers only……

- The Canadian Standard CAN/CSA-B44-94 clause 8.10.1 states similar wording to the ASME 17.1 standard.

- The European EN115 standard makes the statement “transportation of bulky and heavy loads not permitted”

It can therefore be stated that the various International standards for escalators do not recommend the use of carts on escalators.

In the 1992 revision of the UK’s Health & Safety Executive PM34 document the issue of the use of shopping trolleys and luggage trolleys on passenger escalators was addressed however this document was never published. In it, it was stated:

(cl 28) Whenever consideration is being given to the use of trolleys on passenger escalators, the occupier of the premises should ensure that the escalator is suitable for this duty. The trolleys should be specifically designed for use on escalators and compatible with the escalator installed. The occupier must also consider the potential users and loads to be carried.

(cl 29) Trolleys intended for use on escalators should be checked regularly to ensure that they are safe to use in this way. All damaged or defective trolleys should be taken out of service immediately. Trolleys intended for use on escalators should be readily distinguishable from those that are not.

(cl 30) Where trolleys are provided for use on escalators, the following signs should be posted (in addition to the general escalator safety signs):

(a) Simple, clear operating instructions on each trolley at the trolley park and on the approach to the escalator stating, for example:

(1) Drive on straight

(2) Keep your distance

(3) Apply brake

(4) Release brake, drive off

(b) notices should be attached to each trolley to warn against overloading or allowing children to ride in them (except in seats specially provided for that purpose)

(c) Conspicuous safety signs should be posted at the approaches to escalators to remind customers and staff that only specially adapted trolleys should be used on the escalators.

(cl 31) Where trolleys are provided for use on escalators, additional emergency stop

controls should be positioned along the length of the escalators at intervals of 2 metres.

(cl 32) When shopping or luggage trolleys not adapted for use on escalators are being used in the vicinity of escalators, it is important that conspicuous notices be clearly displayed on the approach to the escalators stating that such trolleys should not be taken on to the escalator.

The original PM34 document of 1983 states " cl. 38. Firms and organisations should keep brief records of the details of any accidents involving escalators for which they are responsible. In the case of an accident resulting in a fatal or major injury to anyone (e.g. to an employee or member of the public) the authority responsible for enforcing the HSW act at the premises must be notified immediately; and this must be followed up by a written report on form 2508. This is a requirement of the Notification of Accidents and Dangerous Occurrences Act 1980". This act has now been amended. However there is still a requirement to report fatal accidents. Given the data provided by the HSE previously described it is safe to assume that there have been no accidents on escalators of a serious nature other than those tabulated.

It is noted that there are 4 fatalities reported in the period 1991 to 1998 but it cannot be ascertained whether a trolley/cart was involved in these incidents.

The Boston Globe (1994) reported that the national code requires manufacturers (of escalators) to design brakes that can accommodate 172 lbs (78 kg) per step on an average escalator". Is there therefore scope to overload?

The Ergonomics and Safety Research Unit at Loughborough University have supplied information on shopping trolleys and escalators and in particular an HSE guidance note.

The document reference HS(G)84 is entitled “Shopping Trolleys: Safe system of work guidance”

The author registers surprise at the location of this document as there are four clauses contained within that document specific to escalators and yet no reference to its existence could be found within the lift and escalator industry.

The document states:

39: specially adapted trolleys for use by persons travelling on escalators are available. There are two types of basic trolley:

(a) trolleys which travel on the escalator with the customer; and
(b) trolleys which travel separately on special trolley carriers adjacent to customer escalators.

40: Proper signs/warning notices should be clearly displayed at the approaches to escalators and on the trolley carriers to remind customers and workers that only specially adapted trolleys should be used.

41: Problems may arise if trolleys are not kept on a straight course when they are moved onto an escalator or trolley carrier, as it prevents the capturing mechanism from engaging properly and securely.

42: Trolleys intended for use on escalators and trolley carriers should be checked regularly to ensure that they are safe to use in this way.

It is interesting to note the differences between the unpublished version of the HSE PM34 document (1992) and the HS(G)84 document as tabulated in table 8 below:

HSE PM34 DOCUMENT "SAFE USE OF ESCALATORS"	**HS(G)84 DOCUMENT "SHOPPING TROLLEYS: SAFE SYSTEMOF WORK GUIDANCE"**
Clause 28: ensuring escalator is suitable for trolley use	No comparable clause noted
Clause 28: trolleys to be suitable for use on escalators and compatible with the escalator employed	No comparable clause noted
Clause 28: consideration of loads to be carried	No comparable clause noted
Clause 29: Regular checking of trolley condition	Clause 42 states: Trolleys intended for use on escalators and trolley carriers should be checked regularly to ensure that they are safe to use in this way.

HSE PM34 DOCUMENT "SAFE USE OF ESCALATORS"	**HS(G)84 DOCUMENT "SHOPPING TROLLEYS: SAFE SYSTEMOF WORK GUIDANCE"**
Clause 29: Easy identification of trolleys suitable for use on escalators compared to those that are not	Clause 40 stated: Proper signs/warning notices should be clearly displayed at the approaches to escalators and on the trolley carriers to remind customers and workers that only specially adapted trolleys should be used.
Clause 30: Provision of signage at the trolley park	No comparable clause noted
Clause 30: signage to state: Drive on straight.	Clause 42 states: Problems may arise if trolleys are not kept on a straight course when they are moved onto an escalator or trolley carrier, as it prevents the capturing mechanism from engaging properly and securely.
Clause 30: signage to state: keep your distance	No comparable clause noted
Clause 30: signage to state: apply brake	No comparable clause noted
Clause 30: signage to state: release brake, drive off	No comparable clause noted

HSE PM34 DOCUMENT "SAFE USE OF ESCALATORS"	**HS(G)84 DOCUMENT "SHOPPING TROLLEYS: SAFE SYSTEMOF WORK GUIDANCE"**
Clause 31: Provision of emergency stop controls every 2 metres along the length of the escalator	No comparable clause noted
Clause 32: Clear signage stating that trolleys are not to be used on escalators where they have not been adapted.	Clause 40 stated: Proper signs/warning notices should be clearly displayed at the approaches to escalators and on the trolley carriers to remind customers and workers that only specially adapted trolleys should be used.

Table 8: Comparison of clauses from HSE PM34 (1992) and HS(G)84 documents.

Bearing in mind that these two documents were aimed separately at the escalator industry and the owners of escalators allowing access for carts onto escalators there are significant weaknesses between the unpublished PM34 document and the HS(G)84 document where issues had been identified in the former and not then relayed into the latter document. Criticism therefore has to be leveled at the HSE document entitled HS(G)84 DOCUMENT "SHOPPING TROLLEYS: SAFE SYSTEM OF WORK GUIDANCE" as it fails to address the following points:

- No seeking of guidance as to whether an escalator is suitable.

- No seeking of assurance that carts and escalators are compatible.
- No consideration of loads to be carried.
- No specific requirement for signage at the trolley park.
- No advice on distance to be maintained between carts on the escalator.
- No specific guidance on how to use the cart whilst on or leaving the escalator.
- No mention of the provision of emergency stop controls at additional intervals.

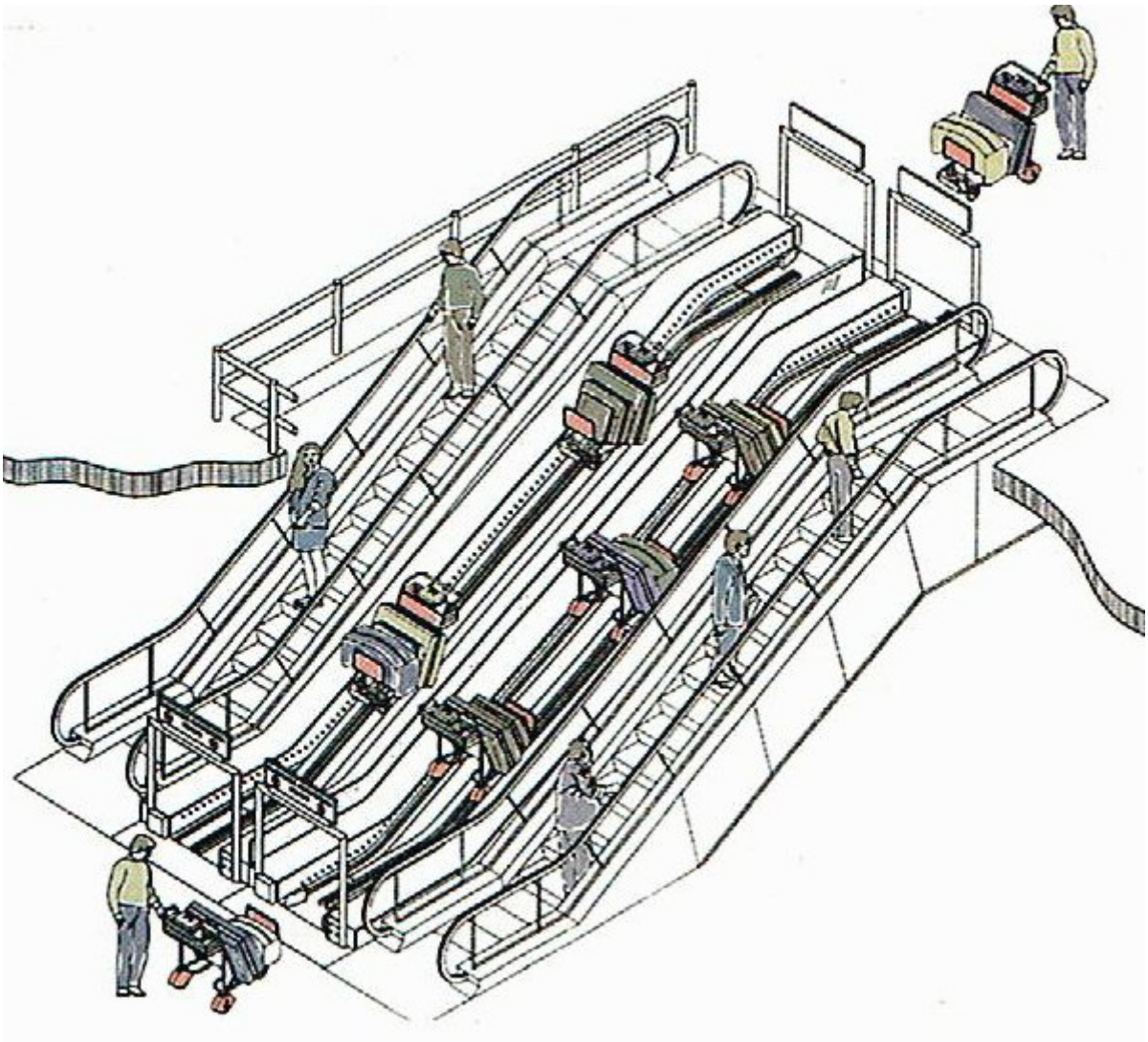
The author has drawn the conclusion that the HS(G)84 DOCUMENT “SHOPPING TROLLEYS: SAFE SYSTEM OF WORK GUIDANCE” is weak in content and fails to give adequate advice to relevant persons.

In stating this one has to acknowledge that the revised PM34 document was never actually published but it is essential to note that contained within it are statements which had clearly been identified as being significant enough to adopt. Even though it was never officially published the fact is that there is nothing else that replaces or supercedes it and it is therefore the best available knowledge to use as a comparison.

THE ALTERNATIVES TO CARTS ON ESCALATORS

Whilst it is acknowledged that carts on escalators is a method which allows the quick transportation of people and accompanied goods there are a number of alternatives:

- Additional elevators
- Moving walkways
- Ramps
- Conveyors that take carts

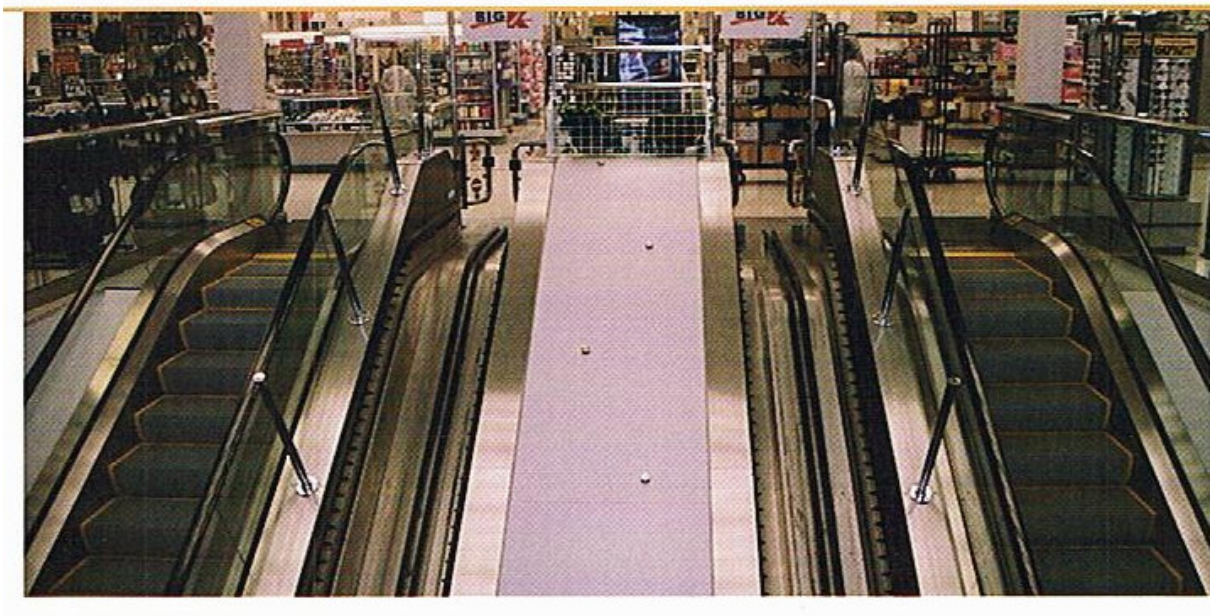


The Vermaport Luggage Cart System

Drawing produced with the kind permission of Vermaport

The above diagram shows a schematic layout of a cart conveyor system installed between two standard escalators. Although the diagram isn't clear in this respect it should be pointed out that with this system (the Vermaport) the carts are maintained level. This means that the tracking profile of the up cart conveyor is different to that of a down cart conveyor.

It is also worth noting that the cart conveyor is designed to run slightly slower than the escalators in order to allow the passenger to arrive at the collection point slightly ahead of their cart.



Photograph reproduced with the kind permission of Vermaport

The different profile between the up and down cart conveyor can be seen in the above photograph.

Photograph reproduced with the kind permission of Vermaport

The above photograph shows a passenger travelling on an escalator beside a cart conveyor.

The advantages/disadvantages of each of the options, including carts on escalators, can be tabulated in table 9 as follows:

Option	Advantages	Disadvantages
Carts on escalators	• Quick movement from floor to floor • Reduced capital cost • Less impact on nett area of locus	• Cost of cart conversion • Possible high incident rate • Possible damage to escalator steps
Additional elevators	• Reduced incident rate	• Initial capital cost • Ongoing maintenance cost • Loss of Nett floor area taken up by additional shafts • Additional waiting time for passengers if sufficient extra elevators aren't installed

Option	Advantages	Disadvantages
Moving walkways	• Reduced incident rate compared to escalators	• Initial capital cost • Loss of Nett floor area taken up • Cost of cart conversion to allow use on moving walkways • Possibility of runaway carts
Ramps	• Reduced incident rate	• Loss of Nett floor area taken up • Possibility of runaway carts
Conveyors that take carts	• Reduced incident rate	• Cost of cart conversion • Initial capital cost • Loss of Nett floor area taken up

Table 9: Comparison of advantages/disadvantages of alternative options to using carts on escalators.

It can be seen that reference to runaway carts has been mentioned in the disadvantages column however statistical data on such incidents was not available at the time of publishing this dissertation.

It is acknowledged that the alternatives to taking carts on escalators will raise safety issues and it was found that child sensors were provided by cart conveyor manufacturers to protect against children gaining access to the system whilst in a cart however such hazards are outside the scope of this dissertation.

(14,603 words)

CONCLUSION

It can be concluded that accidents occur on a fairly regular basis involving carts and also escalators.

It can also be concluded that National Standards do not recommend the practice of carts on escalators.

A number of incidents have been located where injury has been sustained involving a cart being used on an escalator.

It is known that incidents occur in the UK as well as overseas and in particular data has been located for the USA and Germany. It is therefore considered that the problem of the incident rate is associated with the concept of taking carts onto escalators and not as a result of cultural differences between the countries.

Available documentation on the subject is weak and contradictory.

Cart manufacturers derate the safe working load of their carts when used on escalators. It is considered unlikely that users are aware of this.

Accidents located demonstrate the clear risk of:

- Carts and/or their contents losing balance

- Carts and/or their contents becoming crabbed perpendicular to the intended travel direction causing a blockage
- Congestion being caused at access and egress points on an escalator.

It has to be concluded that additional research needs to be undertaken into the concept and in particular:

- It is recommended that a data gathering exercise be undertaken in a store or airport where shoppers or passengers should be invited to guess the weight of their loaded carts as it is suspected that most people may not be able to adequately assess this.

- It is recommended that a data gathering exercise be undertaken to establish whether the escalators involved in accidents involving carts were of a 30° or 35° angle of inclination.

- It is recommended that this data gathering exercise also looks at the impact of the change of measurement statements made on SWL notices having changed to KG in the UK. It is considered that many people may not be able to state loads in KG.

- It is also recommended that an exercise be conducted into whether passengers would be able to identify the differences between a 30º or 35º escalator. It is suspected that many people would be unable to determine a difference.

(14,603 words)

- Given the history of carts rotating on an escalator further research should be undertaken into the effect of side of step safety devices in causing such a rotation. Whilst data was not located that actually blamed such devices it is anticipated that deflector devices such as brush guards could contribute to carts becoming jammed. This should be considered in parallel with the risks associated with side of step entrapment on escalators.

The author is not satisfied that signage is an adequate management tool in the prevention of accidents with trolleys on escalators. In the case of Mrs Solange Evans and her accident at Frankfurt Airport c 1993 it is reported "Graphic lighted signs above the moving steps indicated the procedure to be used in order to get the cart and its user from top to bottom. They indicated that the escalator should be approached head on, cart first, user holding onto the cart, and descending via the moving steps. There was a warning that the cart should not be overloaded and luggage should not be hanging off the sides" (Santa Rosa Sun, 12th May 1993)

There are a number of inconsistencies between environments where escalators and carts are used whether together or not:

- Some environments allow trolleys on escalators, some don't. This may cause confusion.
- Some environments take active steps to prevent trolleys going onto an escalator, some don't. This may infer that it is a permissible practice when it is not.

(14,603 words)

- Some environments have escalators of different manufacture
- Some environments have some adapted trolleys and some that are not

There are inconsistencies in cart manufacturers opinions to carts on escalators:

- Some trolley manufacturers make trolleys for use on escalators, some don't. Given the commercial world in which they compete it is inferred that some manufacturers are not in favour of the concept.

It is also considered that data recording by statutory authorities is poor as locating data is very difficult despite it being known that incidents are occurring. It is recommended that improvements should be made in accident reporting requirements.

The research undertaken in this dissertation reveals that the majority of locus owners who allow the use of carts on escalators are high traffic environments and principally airports and railway stations. In general, retail environments have tended to design their outlets such that carts are used on the level between their car parks and the store. Where this has not been possible lifts, ramps, autowalks or cart conveyors have been employed.

In summary, accidents do occur when the practice of taking carts onto an escalator is enacted by a passenger whether the locus permits this facility or not. Further research is required and it is recommended that an authoritative document into the concept should be drawn up by the relevant safety authorities.

(14,603 words)

REFERENCES

American Society of Mechanical Engineers, (2000), *Elevators & Escalators, ASME A17.1-2000.*

Author n.k (2004), *Shopping Cart Safety*, www.securityworld.com (accessed 3rd August 2004)

Barney, G (2003), *Conversation re escalator & cart accidents*.

Boston Globe (1994). *Risky Ride*

Bradshaw, J, (2000), *Letter re escalator safety*, Schindler

Brooks, S (2002), *Letter re accident at Waterloo*, Leek

BSI, 1995, EN115 *Escalators: manufacturing standard for manufacture of*, London

Buckman, C (2001), *Potential Accidents*, www.elevator-expert.com (accessed June 2003)

Butler, J (2003), *Riding elevators and escalators safely: what parents may not be aware of*, www.eesf.org, EESF

Cain, T (1993), *Inquest into OAP's Death Fall*, Solihull News, Solihull

CAN, (1994), *CAN/CSA-B44-94*, Canadian Standards Authority, Canada

Carporole, R, 2000, *Following suit for escalator safety*, Mobile, Elevator World

CEI, (1985), *812 Analysis techniques for system reliability – procedure for failure mode and effects analysis,* Geneva.

CEI, (1990), *1025 Fault tree analysis*, Geneva.

Cooper, (2001), *Report into Sheila Wroughton v London & Continental Railways*. Eastbourne

CPSC (Consumer Product Safety Commission), (date n.k), *Escalator Safety*, Washington

CPSC, (date n.k), *Escalator Safety for Parents*, www.mass.gov (accessed 3rd August 2004)

CPSC (date n.k), *Falls from Shopping Carts Cause Head Injuries to Children*, www.cpsc.gov (accessed 2003)

CPWR (2001), *Deaths & Injuries Involving Elevators or Escalators*, USA

Deakins, G, (2003) *Letter re escalator safety*, London, HSE

Devor, M (2003) www.airlinequality.com/airports/airport_forum/fra.htm (accessed 29th January 2005)

Elch, S (2003) www.airlinequality.com/airports/airport_forum/fra.htm (accessed 29th January 2005)

Filippone, J et al, (2002), *Elevator & Escalator Accident Reconstruction & Litigation*, Lawyers & Judges Publishing Company, USA

Frankfurt Airport, (2001), *Rolltreppenvorfalle am Flughafen Frankfurt am Main 01/01/2001 – 30/06/2001*, Frankfurt

Haycox, B, (1993), *Escalator ride in Germany changed Navarre couple*, Santa Rosa Sun

Hightpower, A (date n.k), *Escalator Accidents*, Detroit Free Press

HSE, 1992, *Draft revision of PM34 Safety in the use of escalators*, London, Health & Safety Executive

HSE, 1983, *PM34 Safety in the use of escalators*, HMSO, London

HSE, (1992), *HS(G)84 Shopping trolleys; safe system of work guidance*

Huberts, L, 1988, *Unintended Usage*, USA, Elevator World

Haupterverband der Gewerblichen Berufsgenossenschaften (HVBG), (1988), *ZH1/484 Richtlinien fur Fahrtrappen & Fahrsteige*, Germany

Kone (date n.k), *Your Safety*, www.kone.com (accessed 15th June 2004)

Levey, B (1994), *Learn escalator safety*, Washington Post

Frankfurt Allegmaine Newspaper, (1997), *Danger through carelessness and lack of understanding*, Frankfurt Allegmaine Newspaper

NSKC, (date unknown), *Injury facts: shopping cart injury*, USA

Owen, A. 2004, *Review of Escalator safety in UK Airports*, London, BAA

Page, M, et al, (1989), *Ergonomic aspects of escalators in retail environments*, Loughborough, Institute of Consumer Ergonomics, Loughborough

Platt, S et al (1996), *Escalator related injuries in Children*, www.peadiatrics.aappublications.org (accessed 2nd August 2004)

Retail Traders Association of Western Australia (RTWA), (1999), *Shopping trolleys: code of practice for safe management*, Retail Traders Association of Western Australia

Sherwin, F (2002) www.airlinequality.com/airports/airport_forum/fra.htm (accessed 29th January 2005)

Schindler Management Ltd (2001), *Tips for Owners and Managers*, www.schindler.com (accessed15th June 2004)

Smith, G (1999), Summary of a Dateline report about Shopping Carts, www.braininjuryoklahoma.org (accessed 3rd August 2004)

Sturgeon, W, 1987, *A degree of forgiveness*, USA, Elevator World

Sturgeon, W, 1988, *Unintended Usage*, USA, Elevator World

Thorndyke, S, (2000), *Letter re escalator safety*, Thyssen

UK Government, (1980), *Notification of Accidents and Dangerous Occurrences Act 1980*, HMSO, London

UK Government, (1997), *Causes of fatal and serious injuries (all railways),* HMSO, London

(14,603 words)

Walters, W (2002), *Shopping carts and children, a dangerous mix*, USA

Wanzl Cart Manufacturers (1999), *Getting from floor to floor safely*, Wanzl

Wanzl Cart Manufacturers (2000a), *Passenger handling services*, Wanzl

Wanzl Cart Manufacturers (2000b), *Practical elegant airport trolleys* (press release), Leipheim

White, C (1983), *Legal principals of escalator accidents*, Elevator World, Mobile

Wertheim, A H, et al (1998) *An analysis of risks involved in using trolleys on escalators*, Netherlands

Wyllie, G (date n.k), Lifts & Escalator User safety Tips, www.lifts.org.nz (accessed 3rd August 2004)

Yoder, J (c 1997), *Trails, Safety & Risk*, *www.pumpkinvine.org/tsr-498.htm (accessed 9th February 2003)* USA

Young, A (1995) *Airport ignores escalator rule*, Detroit, Detroit Free Press

(14,603 words)

ACKNOWLEDGEMENTS

Dr Gina Barney
Gina Barney Associates

John Bradshaw
Schindler

Kirsty Couper
Buko

Colin Davies
Morris Vermaport (UK)

David Dux
Pflow

Bobbie Haycox
Journalist

Andrea Jenkins
Ergonomics & Safety Research Institute

Evelyn McWilliams
Manual Handling Equipment Distributors Association (USA)

Andrea Mihm
Researcher

Gaynor Morrison
Health & Safety Executive

Amanda Owen
British Airports Authority

David Pelczmann
Vermaport (US)

Stephen Short
A H Brooks & Co

Louis Smith
British Airports Authority

Stephen Thorndyke
Thyssen

(14,603 words)

Terry Viccars
EIS

Tara Westwood
Health & Safety Executive

Carl White
Carl White Associates