An Assessment of Risks at Fairground Rides

A report produced for the Health and Safety Executive

NJ Holloway, R Williams March 1990

SJ Tilson, KM Butler Update of Risk Assessment

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Executive Summary

An original study on the assessment of risks at fairground rides, was performed by SRD in 1990 on behalf of the Health and Safety Executive, to address concerns about risks in the Fairground Rides Industry.

Following a request from the Health and Safety Executive, AEA Technology have been contracted to review and update Section 2 and Appendix 1of the report based on recent accident data.

Contents

1 INTRODUCTION AND PURPOSES OF STUDY

(NOT UPDATED)

2 QUANTITATIVE RISK ASSESSMENTS AND COMPARISONS

The Fairground Ride accident record of deaths and major injuries has been analysed in detail using data provided by the HSE (Appendix 1), noting the accidents to members of the public and to employees (permanent and casual) of the industry.

The statistics on annual ride usage have been estimated by organisations proactive in the fairground industry as amounting to approximately 1 billion rides per year, and accurate local statistics on one fixed site were roughly consistent with this overall estimate. The absolute risk quantification undertaken in this report is based upon this usage statistic. It has been estimated that 5 % of these rides occur on each of the Waltzer and Twist rides since no exact figures are available and because the number of rides of this type in service has decreased due to their increasing age. The typical (average) ride duration has been estimated as 180 seconds (excluding the ride loading and unloading processes).

The risk assessment figures derived in this report provide pessimistic estimates since it was not possible to differentiate between passengers who were injured whilst using fairground rides and fairground ride staff who were injured whilst undertaking normal working practices etc as opposed to onlookers and other causes of injury not directly related to using fairground rides, in the accident data presented in Sections 6.1.2 and 6.1.3.

All risk statistics of the type used here are subject to uncertainties in their estimation.

2.1 Risks to Members of the Public

In view of the current concern regarding the 5 fairground fatalities which have occurred to date in 2000/01, they have been included in the risk of death analysis. However, it was not feasible to include the major injury figures for the present year, as no reliable statistics for the part year are currently available. Therefore the major injury analysis only covers the years 1989/90-1990/00 inclusive.

Over the 12 year period covered by this report, the HSE have recorded 14 fatalities to members of the public in fairground/amusement parks. The largest number of fatalities to occur in any one year is 5 (to date in 2000/01). However, this apparent rise is not statistically significant of an upward trend, as the numbers of fatalities are low and there were a total of 7 years throughout this period in which no fatalities involving members of the public were recorded.

Absolute risks to members of the public were estimated per ride, per second, and per "session", which is defined as a set of 10 rides and is thought to be typical of the activity by a member of the public in a visit to a fairground/amusement park. The results averaged over all rides were:
Risks of Death or Major Injury (KMI):

	1981 – 1987/88*	1989/90 - 1995/96	1996/97 - 1999/00
Risk per ride	**6.4×10^{-8}**	**1.0×10^{-7}**	**4.3×10^{-7}**
Risk per second	**6.4×10^{-10}**	**5.6×10^{-10}**	**2.4×10^{-9}**
Risk per session	**6.4×10^{-7}**	**1.0×10^{-6}**	**4.3×10^{-6}**

*****Figures calculated in previous version of report

Risks of Death (K):

	1981 – 1987/88*	1989/90 - 2000/01**
Risk per ride	**4.0×10^{-9}**	**1.2×10^{-9}**
Risk per second	**4.0×10^{-11}**	**6.7×10^{-12}**
Risk per session	**4.0×10^{-8}**	**1.2×10^{-8}**

*****Figures calculated in previous version of report
**Figures include the 5 fatalities to date, which have occurred in 2000/01

From the above tables, it can be seen that compared to the previous version of the report the risk of major injury to members of the public over the period 1996/97 – 1999/00 has increased.

Over this period there were changes in the accident reporting system. From 1 April 1996, "The Reporting of Injuries, Diseases and Dangerous Occurrences 95 (RIDDOR 95)" came into effect replacing the earlier version of the regulations. Due to a change in the major accident definition in the RIDDOR Regulations 1995, injuries reportable under RIDDOR 95 now include any injuries to members of the public which warrant the injured person being taken from the scene of the accident to a hospital for treatment as major injury accidents. Consequently injury figures from 1996/1997 and thereafter cannot be directly compared to accident figures from previous years.

Therefore although the risks have increased, this is probably an artefact of the number of accidents reported increasing and an increasing knowledge of ergonomic issues etc rather than increasing accident rates. Due to the changes in the reporting system, in reality it is difficult to assign any statistical significance to the apparent rise in the risk of major injury.

[Note: The injury figures used in this report are dependent on the full and accurate reporting of all accidents. It is assumed that all fatal injuries are reported to the HSE, but that not all of the non-fatal injuries that are reportable under RIDDOR95 are reported. Therefore from this perspective the rates of major injuries based on these figures are optimistic and will tend to understate the risk of non-fatal injury.]

2.2 Comparisons with other activities

Comparisons were made between these risks and the risks of some other activities, viz:

In the following section, comparative risks are expressed in terms of Killed (K) and Killed or Seriously injured (KSI) where serious injury is defined as an injury for which a person is detained in hospital as an 'in-patient', or any of the following injuries whether or not they are detained in hospital; fractures, concussion, internal injuries, crushings, severe cuts, and lacerations, severe shock requiring medical treatment, injuries causing death 30 days or more days after the accident.

From the RIDDOR Regulations 1995, the definition of reportable major injuries includes accidents which result in serious injuries. Reportable major injuries include; fractures other than to the fingers, thumbs or toes, amputations, dislocation of the shoulder, hip knee or spine etc. However, there are also a number of relatively minor accidents included in the major injury figures. By definition any member of the public being sent to hospital for treatment is classified as a major injury even though the injury could be a suspected bone fractures, bruising or a superficial injury, which do not result in treatment. Since hospitals will not divulge to non-relatives treatment given to casualties, those responsible for accident reporting at fairgrounds and amusement parks have to report many more accidents than they probably need to because there is no way of knowing whether the injured person is actually treated at hospital or discharged without treatment after 'tender loving care'.

As a result of the requirement to report accidents that require hospital treatment under RIDDOR 95, a number of relatively minor accidents (which cannot be quantified) are included in the calculated risks of being killed or suffering major injury (KMI) on fairground rides. Statistics for other compariator activities generally relate to being killed or seriously injured (KSI) and are therefore not directly comparable with the KMI calculated for fairground rides. However, for illustrative purposes it is considered appropriate to make a comparison so as to provide an indication of the relative risks associated with fairground rides and some other activities.

2.2.1 Transport Activities

Motor car travel associated with travelling to a fairground, assumed to be 30 km each way on an average mix of roads.

Walking to a fairground, assumed to involve half of a normal person's daily pedestrian activity.

Pedal cycling, compared on an equal time of riding basis although the time actually spent pedal cycling in a "session" is likely to be greater than the 30 minutes or so spent riding in a fairground ride "session").

2.2.2 Leisure Activities

Horse riding, for a typical "session".

The risks in these activities are expressed below as the factors by which they differ from the fairground ride risk together with the type of risk [killed (K), or killed or seriously injured (KSI)].

Due to changes in the accident reporting system which came into effect on 1 April 1996, injury figures from 1996/97 and thereafter cannot be directly compared with accident figures from previous years. Therefore for the comparative risks below the killed or seriously injured figures are based on the period 1996/97 – 1999/00. The risk of death is based over the 12 year period 1989/98 – 2000/01.

Thus, given the assumptions stated above, compared to the previous version of the report the risk of being killed or seriously injured in car journeys is now approximately equal (given the uncertainties in the statistics) to the risk of being killed or suffering a major injury in a fairground riding session; (circa 7 times). This is due to the change in the reporting practice and that since 1988 the rate of both killed and killed or seriously injured in car accidents has decreased annually, despite the continuous growth in road traffic. This result is true for all activities subject to risks from road traffic (e.g. pedestrians and pedal cycling). The risk of being killed as a pedestrian on the walk to a fairground is 12 times the risk of being killed in the fairground riding session.

	Relative Risk to Fairgrounds	**Comparison Basis**
Motor Vehicle Travel*	x 20	K Session
Motor Vehicle Travel*	x 0.7	KSI Session
Motor Cycle Riding	x 450	K Session
Motor Cycle Riding	x 20	KSI Session
Walking	x 12	K Session
Walking	x 0.4	KSI Session
Pedal Cycling*	x 39	K Equal Time
Horse Riding	x 1.3	K Session

* There is evidence to suggest that these risks vary considerably with the ages of the participants. In
particular, the risks are higher than average for young persons.

[NB: The relative risks of being killed (K) are over period 1989/90 – 2000/01
and the KSI risks are for the period 1996/97 – 1999/00]

These risk comparisons suggest that the risks from fairground riding are quite small compared with those involved in several other activities which may be considered comparable, are roughly the same as those involved in being a pedestrian on the way to taking part in a leisure activity.

2.3 Risk to Employees

On the basis that there are about 7200 equivalent full-time staff years involved in regular exposure to ride accidents within the industry, the risks to employees were estimated to be:

Risk of Major Injury:

1981 – 1987/88*	1989/90 - 1995/96	1996/97 - 1999/00
3.3×10^{-4}	**1.9×10^{-3}**	**6.0×10^{-3}**

***Figures calculated in previous version of report

Risk of Death:

1981 – 1987/88*	1989/90 - 2000/01**
7.0×10^{-5}	**3.5×10^{-5}**

***Figures calculated in previous version of report

**Figures include the fatalities to date, which occurred in 2000/01

The fatal risk is comparable to the risk at the higher end of the range for other industrial activities[1]. The risk is less than the risk to employees in both the construction industry (5.6×10^{-5} K) and in the manufacture of wood & wood products (4.9×10^{-5} K), but is slightly higher than the risks encountered in metal manufacture (2.1×10^{-5} K). The risk to fairground employees is bounded by the rates of fatal injury in typical manufacturing and process industries (1×10^{-5} K to 5×10^{-5} K). Incidentally, the fatal risk to fairground employees is slightly higher than the average rate of workplace injury in Great Britain, which is 1.9×10^{-5} K. As the risks above are an estimate of the average, it is expected to find some groups exposed to substantially higher, and others to substantially lower, risks.

From the RIDDOR[2] reportable injury rate for 1998/99 the risk of a reportable non-fatal injury to Construction workers is $1.3 \times 10^{-2}$and Manufacturing workers 1.2×10^{-2}. From the Labour Force Survey the risk in terms of a reportable injury to plant and machine operatives is determined to be 3.7×10^{-2}. However, this comparison may be strongly affected by substantial differences in the levels of reporting between industries.

It is assumed that the HSE gets to know virtually all fatal injuries but employers do not report all non-fatal injuries they should under RIDDOR95. Rates of major injuries based on employer reports will therefore understate the risk of non-fatal injury.

Although the small scale of the fairground industry means that the absolute number of employee deaths is small relative to those in large scale industries such as construction, the concept of proportionality suggests that comparable remedies should be applied, noting the ALARP principle in specific circumstances.

[Note: The following reference documents were used to provide comparative risk statistics:

(1) Road Accidents Great Britain, 1999 Department of Transport (DETR). Used for motor vehicle, pedestrian and cycling accident statistics.

(2) Rates of Workplace Injury: Europe and the USA, HSE, 27/09/2000

(3) Levels and trends in Workplace Injury: Reported injuries and the labour Force Survey 1998/99]

[Details of Fairground Industry accident statistics and the risk assessment calculations on which the above numbers are based, are given in Appendix 1.]

[1] Rates of Workplace Injury: Europe and the USA, HSE, 27/09/2000

[2] Levels and trends in Workplace Injury: Reported injuries and the labour Force Survey 1998/99

3 REVIEW OF THE DEFENCES AGAINST ACCIDENTS (NOT UPDATED)

4 RECOMMENDATIONS (NOT UPDATED)

5 CONCLUSIONS (NOT UPDATED)

6 APPENDIX 1

RISK ASSESSMENTS AND COMPARISONS

6.1 The Accident Record

In view of the current concern regarding the 5 fatalities which have occurred to date during 2000/01 in fairgrounds, they have been included in the following sections. However, it was not feasible to include the major injury figures for the present year, as no reliable statistics for the part year are currently available. Therefore the major injury analysis only covers the years 1989/90-1990/00 inclusive.

The risk assessment figures derived in this section provide pessimistic estimates since it was not possible to differentiate between passengers who were injured whilst using fairground rides and fairground ride staff who were injured whilst undertaking normal working practices etc as opposed to onlookers and other causes of injury not directly related to using fairground rides, in the accident data presented below in Sections 6.1.2 and 6.1.3.

The accident record of concern for this study is conveniently summarised in terms of those killed and those who are killed or sustained major injuries, and sub-divided into members of the public and employees.

In the following sections, the abbreviation K is used for Killed and KMI for Killed or Major Injury.

6.1.1 Total Accident Experience 1989/90 – 2000/01

The table below shows the number of fatalities and major injuries to both members of the public and employees in Fairground/Amusement parks reported to the HSE and Local Authorities in Great Britain from 1989/90 – 2000/01.

Year	Fatal	Major Injury	Total
1989/90	-	119	119
1990/91	3	127	130
1991/92	1	95	96
1992/93	-	110	110
1993/94	1	124	125
1994/95	4	104	108
1995/96*	-	106	106
1996/97**	1	479	480
1997/98	1	473	474
1998/99	-	433	433
1999/00p	1	509	510
2000/01p***	5	n/a	n/a

***** Figures before 1995/96 do not include Local Authority accident details.
****** Figures from 1996/97 onwards are for injuries reportable under "The Reporting of Injuries, Diseases and Dangerous Occurrences 95" (RIDDDOR 95) regulations[3] which apply after 01/04/1996.
*******Fatality Figures to date based on current year since April 2000.
p – provisional figures.
n/a – figures not available at time of report.

From the RIDDOR Regulations 1995, the definition of reportable major injuries includes accidents which result in serious injuries. However, there are also a number of relatively minor accidents included in these major injury figures. By definition any member of the public being sent to hospital for treatment is classified as a major injury even though the injury could be a suspected bone fractures, bruising or a superficial injury, which do not result in treatment. Since hospitals will not divulge to non-relatives treatment given to casualties those responsible for accident reporting at fairgrounds and amusement parks have to report many more accidents than they probably need to because there is no way of knowing whether the injured person is actually treated at hospital or discharged without treatment after 'tender loving care'. Therefore the increase in the number of accidents reported from 1996/97 onwards reflect the change in the major accident definition.

6.1.2 Injuries to Members of the Public in Fairgrounds/Amusement Parks

The table below shows the number of fatalities and major injuries to members of the public in Fairground/Amusement parks reported to the HSE and Local Authorities in Great Britain from 1989/90 – 2000/01.

Year	Fatal	Major Injury	Total
1989/90	-	107	107
1990/91	3	108	111
1991/92	-	84	84
1992/93	-	101	102
1993/94	1	109	109
1994/95	4	93	97
1995/96*	-	90	90
1996/97**	-	432	432
1997/98	-	429	429
1998/99	-	398	398
1999/00p	1	464	465
2000/01p***	5	n/a	n/a

***** Figures before 1995/96 do not include Local Authority accident details.
****** Figures from 1996/97 onwards are for injuries reportable under "The Reporting of Injuries, Diseases and Dangerous Occurrences 95" (RIDDDOR (95) regulations which apply after 01/04/1996.
******* Fatality Figures based on current year since April 2000.
p – provisional figures
n/a – figures not available at time of report

[3] There were changes in the accident reporting system from 1996, namely "The Reporting of Injuries, Diseases and Dangerous Occurrences 95 (RIDDOR 95)" which came into effect on 1 April 1996 replacing the first version of RIDDOR regulations, consequently injury figures from 1996/1997 and thereafter cannot be directly compared to accident figures from previous years. Injuries reportable under RIDDOR 95 now include any injuries to members of the public which warrant the injured person being taken from the scene of the accident to a hospital for treatment.

6.1.3 Injuries to Self Employed and Employees in Fairgrounds/Amusement Parks

The table below shows the number of fatalities and major injuries to employees in Fairground/Amusement parks reported to the HSE and Local Authorities in Great Britain from 1989/90 – 2000/01.

Year	Fatal	Major Injury	Over 3 Day	Total
1989/90	-	12	17	29
1990/91	-	19	19	38
1991/92	1	11	16	28
1992/93	-	9	18	27
1993/94	-	15	22	37
1994/95*	-	11	14	25
1995/96**	-	16	20	36
1996/97	1	47	117	165
1997/98	1	44	146	191
1998/99	-	35	80	115
1999/00p	-	45	83	127
2000/01p***	-	n/a	n/a	n/a

***** Figures before 1995/96 do not include Local Authority accident details.
****** Figures from 1996/97 onwards are for injuries reportable under "The Reporting of Injuries, Diseases and Dangerous Occurrences 95" (RIDDDOR (95) regulations which apply after 01/04/1996.
******* Fatality Figures based on current year since April 2000.
p – provisional figures
n/a – figures not available at time of report

The **Over 3 Day** category represents accidents where personal injury results in an absence from work or the person being unable to undertake their normal work duties for more than three calendar days, but does not fall into the categories specified as a major injury.

6.1.4 Fatality Accident Rate

From Section 6.1.2 and 6.1.3 the average fatality accident rate over the period 1989/90 - 2000/01 can be calculated:

	1989/90 – 2000/01*
Members of the Public	**1.2 K**
Fairground Employees	**0.25 K**

*Figures include the 5 fatalities to date, which have occurred in 2000/01

6.1.5 Major Injury Accident Rate

From Section 6.1.2 and 6.1.3 the average accident rate, which results in a person being killed or suffering major injury, can be calculated:

	1989/90 – 1995/96	1996/97 – 1999/00
Members of the Public	**100 KMI**	**431 KMI**
Fairground Employees	**13.4 KMI**	**43.3 KMI**

Major Injury accident data for 2000/01 not available at time of report.

6.1.6 Accident Experience

This section summarises the type of accident resulting in injury/fatality of the accidents reported to the HSE and Local Authorities, the number of injuries by ride type and the number of accidents by main cause group for the accidents that were investigated. It should be noted that HSE only a investigate proportion of the reported injuries and that the number of accidents and the number of fatalities/injuries are not the same as there can be more than one person involved per accident and there are no injured persons from reported dangerous occurrences (which are included within the number of accidents).

The accident reporting system changed from 1996, namely "The Reporting of Injuries, Diseases and Dangerous Occurrences 95 (RIDDOR 95)" which came into effect on 1 April 1996 and replaced an earlier version of the regulations. Injuries reportable under RIDDOR 95 now include any injuries to members of the public which warrant the injured person from being taken from the scene of the accident to a hospital for treatment. The regulations also require incidents to be reported where, even though a reportable incident did not result, it clearly could have, as a dangerous occurrence.

Principal accident causes have been categorised into structural / mechanical fault, operator error, inadequate design, passenger behaviour, slips/falls and other/cause unknown. The types of accidents within the cause groups that need explanation are detailed below.

Structural and mechanical faults include accidents where parts of the ride have collapsed or where pieces of the ride have been ejected inflicting injury. This type of accident is indicative of poor maintenance and incorrect assembly.

Inadequate design covers instances where better design of the ride, particularly the passenger carrying units and/or the passenger restraints would have prevented the accident.

Passenger behaviour includes unruly behaviour, over excitement, alcohol abuse, horseplay, failure to follow instructions issued by ride operators and inappropriate use of equipment. Accidents where passengers have not waited for the ride to stop completely before disembarking and also occurrences where passengers have deliberately stuck out a hand or leg which has come into contact with another object causing injury have been classified as accidents where passenger behaviour has been the prevailing cause.

6.1.6.1 Main Cause Groups for Accidents 1989/1990

This sections summarises the data on accidents / injuries that were reported to and investigated by the HSE for 1989/90.

Accident Type for injuries reported to HSE (public and workers) 1989/1990

Accident Type	**Number of Injured Persons**		
	Fatal	**Major**	**Total**
Struck by moving, including flying or falling objects	-	6	6
Fall from height	-	36	36
Walk into object	-	3	3
Contact with moving machinery or material being machined	-	26	26
Struck by moving vehicle	-	2	2
Trapped by something collapsing or overturning	-	1	1
Exposure or contact with harmful substance	-	1	1
Slip, trip or fall on same level	-	36	36
Other kind of accident (or not classified)	-	8	8
TOTAL	**0**	**119**	**119**

Main Cause Group for Investigated Accidents 1989/1990

Cause	No. of Accidents
Structural / Mechanical Fault	19
Operator Error	9
Passenger Behaviour	9
Inadequate Design	7
Slips / falls	18
Other/Cause Unknown	7

Number of Injuries Investigated by Ride Type 1989/1990

Type of Ride	Fatalities	Major Injury
Power Operated (excluding Cyclone Twist and Waltzer)	-	39
Cyclone Twist	-	2
Waltzer	-	6
Unpowered Rides (e.g. Helter Skelter, Bouncy Castle)	-	3
Static playground (e.g. Swings, Climbing Frames)	-	19

Of the 69 major injuries investigated by the HSE in 1989/90: 64 related to members of the public; 4 to ride attendants on power operated rides and 1 to a YTS attendant on a bouncy castle. The injuries to the 4 ride attendants on power operated rides were all a result of human error. In two separate incidents, attendants entered the ride compounds before the rides had come to a complete stop and were caught by passenger cars. Another fairground worker was injured when he decided to have a ride in an empty car. When ride was coming to a stop he opened the safety gate and on dismounting slipped and broke his leg. Incidentally, the catch on the gate was positioned to prevent easy access by passengers but the injured person reached over and let himself out. An attendant on a Rapids ride was injured when he was trying to separate 2 rafts which had jammed together at the bottom of this water ride. Another raft collided with the first 2 and the attendant's foot was tapped between the rafts. The amusement park was advised to extend existing instructions for the ride attendants to cater for this type of blockage/hazard.

In a separate incident on a Log Flume ride, four people required hospital treatment and a further 10 sustained minor injuries. The water level in the run out area of the main lift fell due to a pump malfunction and consequently the braking effect on boats was lost. Technical modifications have been undertaken. A dangerous occurrence also occurred on another Log flume because of a failure of the water level supply pump. However in this incident a water level switch should have stopped the ride when the water level fell, but the switch was short circuited due to water in switch.

6.1.6.2 Main Cause Groups for Accidents 1990/1991

This sections summarises the data on accidents / injuries that were reported to and investigated by the HSE for 1990/91.

Accident Type for injuries reported to HSE (public and workers) 1990/1991

Accident Type	Number of Injured Persons		
	Fatal	Major	Total
Struck by moving, including flying or falling object	-	5	5
Fall from height	2	32	34
Walk into object	-	17	17
Contact with moving machinery or material being machined	1	20	21
Struck by moving vehicle	-	7	7
Slip, trip or fall on same level	-	30	30
Injured whilst handling, lifting or carrying	-	2	2
Exposure or contact with Harmful substance	-	1	1
Other kind of accident (or not classified)	-	13	13
TOTAL	**3**	**127**	**130**

Main Cause Group for Investigated Accidents 1990/1991

Cause	No. of Accidents
Structural / Mechanical Fault	15
Operator Error	15
Passenger Behaviour	12
Inadequate Design	5
Slips / falls	16
Other/Cause Unknown	10

Number of Injuries Investigated by Ride Type 1990/1991

Type of Ride	Fatalities	Major Injury
Power Operated (excluding Cyclone Twist and Waltzer)	-	49
Cyclone Twist	1	4
Waltzer	-	2
Unpowered Rides (e.g. Helter Skelter, Bouncy Castle)	-	4
Karts	-	2
Static playground (e.g. Swings, Climbing Frames)	2	9
Other	-	1

Of the 71 major injuries investigated by the HSE in 1990/91: 61 related to members of the public; 3 to maintenance employees and 7 to ride attendants of which one was an attendant at a shooting galley at a fairground, and one was an attendant at a karting track. The other 5 were attendants on power operating rides, including a cyclone twist.

Only one fatal accident occurred in 1990/91 on power operated fairground rides. A 2 year old passenger on a Cyclone Twist ride slipped under the safety bar and was then thrown off the ride and subsequently struck by other parts of the machine. There were no age or height restrictions on persons allowed to ride. In a separate incident on a Cyclone Twist ride, an attendant received serious head injuries from attempting to jump onto the ride while it was in operation (contrary to good practice recommendations).

The other 2 fatal accidents occurred in children's playgrounds. In one incident a girl fell off a swing directly onto concrete paving slabs beneath receiving fatal injuries. In the other incident a child received fatal injuries after sliding down a slide head first.

6.1.6.3 Main Cause Groups for Accidents 1991/1992

This sections summarises the data on accidents / injuries that were reported to and investigated by the HSE for 1991/92.

Accident Type for Injuries Reported to HSE (public and workers) 1991/1992

Accident Type	Number of Injured Persons		
	Fatal	Major	Total
Struck By moving, including flying or falling object	-	7	7
Fall from height	-	18	18
Walk into object	-	10	10
Contact with moving machinery or material being machined	-	26	26
Struck by moving vehicle	-	3	3
Slip, trip or fall on same level	-	16	16
Injured whilst handling, lifting or carrying	-	3	3
Trapped by something collapsing or overturning	-	2	2
Contact with electricity	1	1	2
Other kind of accident (or not classified)	-	9	9
TOTAL	**1**	**95**	**96**

Main Cause Group for Investigated Accidents 1991/1992

Cause	No. of Accidents
Structural / Mechanical Fault	10
Operator Error	11
Passenger Behaviour	10
Inadequate Design	9
Slips / falls	7
Other/Cause Unknown	4

Number of Injuries Investigated by Ride Type 1991/1992

Type of Ride	Fatalities	Major Injury
Power Operated (excluding Cyclone Twist and Waltzer)	1	38
Cyclone Twist	-	1
Waltzer	-	3
Unpowered Rides (e.g. Helter Skelter, Bouncy Castle)	-	6
Static playground (e.g. Swings, Climbing Frames)	-	11

Of the 59 major injuries investigated by the HSE in 1991/92: 57 related to members of the public; 1 to a maintenance employees injured while dismantling a Waltzer ride and 1 to a ride attendant on a power operated rides who slipped from a roller coaster whilst attempting to release a passenger safety harnesses. Incidentally the operator should have waited for maintenance staff/fitters.
The one fatal injury to occur in 1991/92 was to an employee who was electrocuted whilst assisting in the dismantling of a Sizzler Twist ride at a travelling fairground.

The only incident investigated on a Cyclone Twist ride was at a travelling fairground. A passenger suffered major injury as he was ejected from the ride when the safety bar detached from the locking device. No mechanical fault was found with the locking device and the cause of the accident was identified as the attendant not having properly securing the restraint bar.

6.1.6.4 Main Cause Groups for Accidents 1992/1993

This sections summarises the data on accidents / injuries that were reported to and investigated by the HSE for 1992/93.

Accident Type for injuries reported to HSE (public and workers) 1992/1993

Accident Type	Number of Injured Persons		
	Fatal	Major	Total
Struck by moving, including flying or falling object	-	8	8
Fall from height	-	30	30
Walk into object	-	7	7
Contact with moving machinery or material being machined	-	25	25
Struck by moving vehicle	-	4	4
Slip, trip or fall on same level	-	13	13
Injured whilst handling, lifting or carrying	-	3	3
Other kind of accident (or not classified)	-	20	20
TOTAL	**0**	**110**	**110**

Main Cause Group for Investigated Accidents 1992/1993

Cause	No. of Accidents
Structural / Mechanical Fault	13
Operator Error	19
Passenger Behaviour	10
Inadequate Design	19
Slips / falls	5
Other/Cause Unknown	5

Number of Injuries Investigated by Ride Type 1992/1993

Type of Ride	Fatalities	Major Injury
Power Operated (excluding Cyclone Twist and Waltzer)	-	48
Cyclone Twist	-	1
Waltzer	-	1
Unpowered Rides (e.g. Helter Skelters, bouncy castles)	-	7
Karts	-	3
Static playground (e.g. swings, climbing Frames)	-	11

Of the 71 major injuries investigated by the HSE in 1992/93: 67 related to members of the public; 1 to a maintenance employee who received a glancing blow from a passing roller coaster when they stepped back to inspect light fitting repair just undertaken. 3 ride attendants were injured, 2 of which worked on power operated rides. The third attendant was injured on an unpowered Toboggan type ride.

4 members of the public suffered injury whilst on a Tagada ride at a travelling fairground which was being operated incorrectly. The tilt mechanism was being used when the ride was revolving slowly which is contrary to good practice. In a separate incident on a Tagada ride another passenger suffered major injuries when a fellow passenger became dislodged from his seat and fell onto the injured person. Mode of operation of ride included “bumping of ride” whilst not revolving.

20 people sustained minor injuries at a travelling fair when a ski jump type ride collapsed due to painted wooden packing blocks slipping out from under a vertical load bearing stanchion leading to track distortion and failure of linking components.

There were several incidents on Waltzer fairground rides in 1992/93 due to structural faults. The supporting platform on a Waltzer collapsed causing distortion to the general framework and the nuts on two bolts connecting the running track to become displaced allowing track to fall. Passengers in two cars suffered minor injuries. The cause was either vibration and/or nuts not having been secured properly. In another incident several passengers received minor injuries when the track support on a Waltzer ride broke.

An experienced fairground ride attendant received major injuries when he mounted a Waltzer platform at a flat spot between 2 cars, as instructed by the ride owner, contrary to safe practice. As cars rose up the slope, a car on the right spun round knocking the attendant to the floor.

Three persons were ejected from a Spritzer fairground ride at a travelling fair when the safety restraint bar failed. The HSE investigation concluded that operator error was the cause of the accident, as the safety bar was not in place at the start of ride and no mechanical defects were found. Approximately a month later the same ride was involved in another incident where two passengers were ejected. There were no perceptible defects in the guard bar interlocking arrangement. However, the ride was removed from service by operator for guard bar improvements.

6.1.6.5 Main Cause Groups for Accidents 1993/1994

This sections summarises the data on accidents / injuries that were reported to and investigated by the HSE for 1993/94.

Accident Type for injuries reported to HSE (public and workers) 1993/1994

Accident Type	Number of Injured Persons		
	Fatal	Major	Total
Struck by moving, including flying or falling object	-	6	6
Fall from height	1	40	40
Walk into object	-	16	16
Contact with moving machinery or material being machined	-	21	21
Struck by moving vehicle	-	1	1
Slip, trip or fall on same level	-	23	23
Injured whilst handling, lifting or carrying	-	1	1
Trapped by something collapsing or overturning	-	3	3
Other kind of accident (or not classified)	-	13	13
TOTAL	**1**	**124**	**125**

Main Cause Group for Investigated Accidents 1993/1994

Cause	No. of Accidents
Structural / Mechanical Fault	14
Operator Error	12
Passenger Behaviour	10
Inadequate Design	13
Slips / falls	11
Other/Cause Unknown	1

Number of Injuries Investigated by Ride Type 1993/1994

Type of Ride	Fatalities	Major Injury
Power Operated (excluding Cyclone Twist and Waltzer)	-	32
Cyclone Twist	-	-
Waltzer	-	3
Unpowered Rides (e.g. Helter Skelter, Bouncy Castle)	-	4
Karts	-	1
Static playground (e.g. Swings, Climbing Frames)	-	15
Other	1	1

Of the 56 major injuries investigated by the HSE in 1993/94: 55 related to members of the public and 1 to a ride attendant on a Waltzer ride. An experienced attendant was trying to slow car down when a ring on finger caught a screw head on back of the passenger car. Attendant had been advised to remove ring before stating work.

The one fatality, which occurred in 1993/94, was a result of a child falling from a pick-up being used by an employee checking play areas.

6.1.6.6 Main Cause Groups for Accidents 1994/1995

This sections summarises the data on accidents / injuries that were reported to and investigated by the HSE for 1994/95.

Accident Type for injuries reported to HSE (public and workers) 1994/1995

Accident Type	Number of Injured Persons		
	Fatal	Major	Total
Struck by moving, including flying or falling object	-	8	8
Fall from height	1	24	24
Walk into object	2	11	13
Contact with moving machinery or material being machined	1	22	23
Struck by moving vehicle	-	3	3
Slip, trip or fall on same level	-	18	18
Trapped by something collapsing or overturning	-	1	1
Other kind of accident (or not classified)	-	17	17
TOTAL	**4**	**104**	**108**

Main Cause Group for Investigated Accidents 1994/1995

Cause	No. of Accidents
Structural / Mechanical Fault	12
Operator Error	12
Passenger Behaviour	12
Inadequate Design	14
Slips / falls	2
Other/Cause Unknown	2

Number of Injuries Investigated by Ride Type 1994/1995

Type of Ride	Fatalities	Major Injury
Power Operated (excluding Cyclone Twist and Waltzer)	2	27
Cyclone Twist	-	1
Waltzer	-	3
Unpowered Rides (e.g. Helter Skelter, Bouncy Castles)	-	4
Static playground (e.g. Swings, Climbing Frames)	2	10

Of the 45 major injuries investigated by the HSE in 1994/95: 39 related to members of the public and 6 to ride attendants, 5 of whom were employed on power operated rides and 1 was an attendant in a soft play area.
In one incident a casual attendant was struck twice by passenger cars on a Cyclone twist ride. The attendant either walked across the platform or stepped out of a car whilst ride was in motion. Another attendant was injured on a Top Spin fairground ride. In this case the attendant was retrieving stored shutters from beneath the Top spin and was struck by revolving ride as it descended to the horizontal. An additional barrier enclosure was added and there is no longer equipment stored in vicinity of ride.

Two fatal accidents occurred on power operated rides in 1994/95. One incident was caused by the structural collapse of a lighting support arch at a fixed amusement park onto a water chute track. A passenger car collided with the support arch and one passenger was fatally injured with three others receiving major injuries. In the other incident a passenger was fatally injured when he fell from a power operated ride sustaining fatal head injuries. The ride was in good condition and the operators were experienced. It is suspected that passenger behaviour was the prominent factor that caused the accident.

The 2 other fatalities to occur in 1994/95 were in recreation areas on swings. Both of these accidents occurred as a result of passenger behaviour. In one instance alcohol was considered the major factor and in the other the passenger was using the equipment inappropriately.

The total number of accidents in 1994/95 was dominated by the structural failure of several power operated rides. In one such incident a powered roundabout collapsed while in operation at a fixed amusement park due to the double fracture of the main pivot shaft. 22 passengers were on the ride at the time of the incident with 10 receiving minor injuries. In another incident on a roller coaster at a fixed amusement park the main bogie frame support on one of the cars sheared off due to fatigue at a change in section. The axle was a copy of the original and lacked crucial radius at change of section. A number of the 36 passengers sustained minor injuries.

At another fixed amusement park 46 passengers were injured 2 of whom received major injuries in a collision on a roller coaster. The accident was caused when a brake failed to hold one of the trains and it ran into the rear of the preceding train. Investigation revealed major inadequacies in the design, verification and commissioning of the ride.

6.1.6.7 Main Cause Groups for Accidents 1995/1996

This sections summarises the data on accidents / injuries that were reported to and investigated by the HSE for 1995/96.

Accident Type for Injuries Reported to HSE (public and workers) 1995/1996

Accident Type	Number of Injured Persons		
	Fatal	Major	Total
Struck by moving, including flying or falling objects	-	8	8
Fall from height	-	40	40
Walk into object	-	10	10
Contact with moving machinery or material being machined	-	10	10
Struck by moving vehicle	-	1	1
Slip, trip of fall on same level	-	24	24
Trapped by something collapsing or overturning	-	1	1
Injured whilst handling, lifting or carrying	-	2	2
Anoxia	-	1	1
Other kind of accident (or not classified)	-	9	9
TOTAL	**0**	**106**	**106**

Main Cause Group for Investigated Accidents 1995/1996

Cause	No. of Accidents
Structural / Mechanical Fault	8
Operator Error	7
Passenger Behaviour	5
Inadequate Design	8
Slips / falls	8
Other/Cause Unknown	5

Number of Injuries Investigated by Ride Type 1995/1996

Type of Ride	Fatalities	Major Injury
Power Operated (excluding Cyclone Twist and Waltzer)	-	22
Cyclone Twist	-	1

Waltzer	-	1
Unpowered Rides (e.g. Helter Skelter, Bouncy Castle)	-	3
Static playground (e.g. Swings, Climbing Frames)	-	11
Other	-	1

Of the 39 major injuries investigated by the HSE in 1995/96: 38 related to members of the public and 1 to a ride attendant working on a power operated ride. The attendant was struck on the head by a revolving car whilst walking across ride platform during operation of the ride.

One person sustained major injuries on a Cyclone Twist ride when they were thrown from the ride because the passenger restraint opened whilst the ride was in motion. The ratchet mechanism in the restraint was found to be poorly maintained. Another member of the public received major injuries on a Waltzer ride. The injured person used to be employed on the Waltzer and was seeking a free ride. When refused, with ride coasting while money collection time ended, injured person stepped from paybox (area where attendants ride) and caught leg on edge of paybox platform receiving major injuries.

6.1.6.8 Main Cause Groups for Accidents 1996/1997

This sections summarises the data on accidents / injuries that were reported to and investigated by the HSE for 1996/97.

Accident Type for injuries reported to HSE (public and workers) 1996/1997

Accident Type	Number of Injured Persons		
	Fatal	Major	Total
Struck by moving, including flying or falling object	1	70	71
Fall from height	-	81	81
Strike/Step On against something fixed or stationary	-	70	70
Contact with machinery or material being machined	-	15	15
Struck by moving vehicle	-	27	27
Slip, trip of fall on same level	-	128	128
Injured whilst handling, lifting or carrying	-	15	15
Exposure or contact with harmful/hot substance	-	4	4
Contact with electricity	-	1	1
Trapped by something collapsing or overturning	-	1	1
Drowning/Asphyxiation	-	1	1
Injuries caused by assault or violence	-	1	1
Injured by animal	-	3	3
Not Known	-	5	5
Other Kind of accident (or not classified)	-	57	57
TOTAL	**1**	**479**	**480**

Main Cause Group for Investigated Accidents 1996/1997

Cause	No. of Accidents
Structural / Mechanical Fault	4
Operator Error	12
Passenger Behaviour	13
Inadequate Design	4
Slips / falls	4
Other/Cause Unknown	7

Number of Injuries Investigated by Ride Type 1996/1997

Type of Ride	Fatalities	Major Injury
Power Operated (excluding Cyclone Twist and Waltzer)	1	26
Cyclone Twist	-	3
Waltzer	-	2
Unpowered Rides (e.g. Helter Skelter, Bouncy Castle)	-	8
Karts	-	2
Static playground (e.g. Swings, Climbing Frames)	-	2
Other	-	2

Of the 45 major injuries investigated by the HSE in 1996/97: 40 related to members of the public; 2 to maintenance employees and 1 to a ride attendant. 2 other fairground employees at fixed amusement parks were injured but their daily activities and injuries were not as a consequence of fairground rides. A retail employee caught his foot on raised lip of a drainage channel cover causing him to fall and break his arm and an employee working in the cash kiosk at the main entrance failed to secure window properly and was struck on head.

All of the other investigated injuries to fairground employees were as a result of operator error. The ride attendant was injured as he tried to spin a passenger car on a Waltzer ride (a practice which is not approved of by the HSE). One of the maintenance employees was injured when he fell 3 metres from the track of a roller coaster he was maintaining. A harness was provided but was not being used at the time of the incident. In the other investigated incident the injured person was an experienced electrician who forgot to isolate the electricity supply at the board for the fairground ride he was fault testing even though the Isolator was immediately to hand. A simple lapse on the part of a trained employee.

The only fatality, which occurred in the 1996/97 season, was to a self-employed fairground worker undertaking repair and modification work on a power operated fairground ride. The machine was required to be in operation for the work being undertaken but it appears that he decided to perform another task instead. The emergency stop wiring was by passed (unsafe practice) and for reasons unknown he was found trapped in the machine.

In 1996/97 there were a total of 19 notices issued by the HSE: 3 improvement notices and 16 prohibition notices were issued under Section 2 or Section 3 of the Health and Safety at Work Act 1974.

6.1.6.9 Main Cause Groups for Accidents 1997/1998

This sections summarises the data on accidents / injuries that were reported to and investigated by the HSE for 1997/98.

Accident Type for injuries reported to HSE (public and workers) 1997/1998

Accident Type	Number of Injured Persons		
	Fatal	Major	Total
Struck by moving, including flying or falling object	1	46	47
Fall from height	-	79	79
Strike against something fixed or stationary	-	68	68
Contact with moving machinery or material being machined	-	20	20
Struck by moving vehicle	-	25	25
Slip, trip or fall on same level	-	132	132
Injured whilst handling, lifting or carrying	-	14	14
Exposure or contact with harmful/hot Substance	-	3	3
Trapped by something collapsing or overturning	-	2	2
Drowning/Asphyxiation	-	1	1
Injuries caused by assault or violence	-	2	2
Injured by animal	-	1	1
Not Known	-	6	6
Other Kind of accident (or not classified)	-	74	74
TOTAL	**1**	**473**	**474**

Main Cause Group for Investigated Accidents 1997/1998

Cause	No. of Accidents
Structural / Mechanical Fault	6
Operator Error	5
Passenger Behaviour	9
Inadequate Design	13
Slips / falls	2
Other/Cause Unknown	5

Number of Injuries Investigated by Ride Type 1997/1998

Type of Ride	Fatalities	Major Injury
Power Operated (excluding Cyclone Twist and Waltzer)	1	27
Cyclone Twist	-	2
Waltzer	-	2
Unpowered Rides (e.g. Helter Skelter, Bouncy Castle)	-	4
Karts	-	3
Static playground (e.g. Swings, Climbing Frames)	-	1

Of the 39 major injuries investigated by the HSE in 1997/98: 38 related to members of the public and 1 to a ride attendant on a power operated Twist ride. The injured attendant was sat properly on the ride to balance it. However, as the ride was slowing down the attendant used his foot to release the restraint locking mechanism and subsequently fell and was dragged at least half way round the ride causing injury.

The one fatality, which occurred in 1997/98, was to a ride attendant on a multi-revolutionary power operated ride at a travelling fairground. The ride attendant was fatally injured when he walked from an access opening at the perimeter of a ride into the centre of the ride while the ride was in motion. The ride attendant was experienced, and there were no problems with crowd control. No rational explanation is available to account for the ride attendants' actions.

In 1997/98 there were a total of 13 notices issued by the HSE: 2 improvement notices and 11 prohibition notices were issued under Section 2 or Section 3 of the Health and Safety at Work Act 1974.

6.1.6.10 Main Cause Groups for Accidents 1998/1999

This sections summarises the data on accidents / injuries that were reported to and investigated by the HSE for 1998/99.

Accident Type for injuries reported to HSE (public and workers) 1998/1999

Accident Type	Number of Injured Persons		
	Fatal	Major	Total
Contact with moving machinery or material being machined	-	18	18
Struck by moving, including flying or falling object	-	43	43
Struck by moving vehicle	-	20	20
Strike against something fixed or stationary	-	70	70
Injured whilst handling, lifting or carrying	-	11	11
Slip, trip or fall on same level	-	117	117
Falls from height	-	86	86
Trapped by something collapsing or overturning	-	1	1
Drowning or asphyxiation	-	3	3
Exposure to fire	-	1	1
Exposure or contact with harmful/hot substance	-	2	2
Injuries caused by assault or violence	-	2	2
Injured by animal	-	1	1
Other kind of accident (or not classified)	-	58	58
TOTAL	**0**	**433**	**433**

Main Cause Group for Investigated Accidents 1998/1999

Cause	No. of Accidents
Structural / Mechanical Fault	3
Operator Error	8
Passenger Behaviour	7
Inadequate Design	10
Slips / falls	2
Other/Cause Unknown	2

Number of Injuries Investigated by Ride Type 1998/1999

Type of Ride	Fatalities	Major Injury
Power Operated (excluding Cyclone Twist and Waltzer)	-	25
Cyclone Twist	-	2
Waltzer	-	4
Unpowered Rides (e.g. Helter Skelter, Bouncy Castle)	-	2
Karts	-	1
Static playground (Swings, Climbing Frames)	-	2

Of the 36 major injuries investigated by the HSE in 1998/99: 34 related to members of the public and 2 to ride attendants on power operated rides.

In one of these cases, an attendant jumped onto the ride platform to close a restraint on an empty car. However, the ride operator did not see the attendant on the platform and started ride. The attendant slipped and his leg was trapped under a revolving car. In the other incident investigated, a ride attendant was injured by a decorative strip on one side of the passenger cars. It is believed that as the train came into the platform he moved to the edge in order to release handles outside the cars that

control the safety bar ratchets. The ride owners have had to trim the ends of some of the strips in the past as they vibrate loose. The problem does not arise on the customer platform (the other side), as the platform is higher – above the trim level.

Of the four injuries received on Waltzer rides, one was due to inadequate design of the head restraints enabling a passenger to place their head outside of the car they were riding in, resulting in it being struck by another car. Another incident which resulted in injury, was as a result of horseplay. The third incident which resulted in two injuries, was due to inadequate supervision of the ride. The ride attendants allegedly issued no instructions to the crowd situated on the platform around the edge of the ride to keep back. Consequently an onlooker was knocked into the ride while it was in operation receiving injuries. Earlier another passenger was also knocked into the ride (although this not reported to the ride attendant at the time) causing a broken ankle.

In 1997/98 there were a total of 32 notices issued by the HSE; 12 improvement notices and 20 prohibition notices were issued under Section 2 or Section 3 of the Health and Safety at Work Act 1974.

6.1.6.11 Main Cause Groups for Accidents 1999/2000

This sections summarises the data on accidents / injuries that were reported to and investigated by the HSE for 1999/00.

Accident Type for Injuries Reported to HSE (public and workers) 1999/2000

Accident Type	Number of Injured Persons		
	Fatal	Major	Total
Contact with moving machinery or material being machined	-	28	28
Struck by moving, including flying or falling object	-	72	72
Struck by moving vehicle	-	10	10
Strike against something fixed or stationary	-	90	90
Injured whilst handling, lifting or carrying	-	25	25
Slip, trip or fall on same level	-	109	109
Falls from height	-	91	91
Contact with electricity	-	2	2
Injured by animal	-	3	3
Exposure or contact with harmful substance	-	1	1
Other king of accident (or not classified)	1	78	79
TOTAL	**1**	**509**	**510**

Main Cause Group for Investigated Accidents 1999/2000

Cause	No. of Accidents
Structural / Mechanical Fault	11
Operator Error	19
Passenger Behaviour	11
Inadequate Design	13
Slips / falls	5
Other/Cause Unknown	4

Number of Injuries Investigated by Ride Type 1999/2000

Type of Ride	Fatalities	Major Injury
Power Operated (excluding Cyclone Twist and Waltzer)	1	53
Cyclone Twist	-	7
Waltzer	-	5
Unpowered Ride (e.g. Helter Skelter, Bouncy Castle))	-	3
Karts	-	1
Static playground (e.g. Swings, Climbing Frames)	-	1
Other	-	1

Of the 71 major injuries investigated by the HSE in 1999/00: 67 related to members of the public, 1 to a maintenance employee and 3 to ride attendants on power operated rides.

In one of these incidents the injured person was an attendant on the go-karts who was talking to a friend next to operators box on the Waltzer. The injured person then walked across the Waltzer platform whilst it was still moving, mis-judged the speed and was thrown hitting his head against the entrance pillar after being caught by one of the cars. Another attendant received serious head injuries from a bolt from a dee-shackle, which fell off the ride. The third ride attendant was injured by a slip/fall. The maintenance worker was injured while helping a colleague to push a passenger car along a level part of the roller-coaster track. The cars were undergoing their pre-start testing and with no weight in the cars they sometimes did not travel far enough along the straight section of the track prior to the chain pick up for the inclined section of the ride.

The biggest single group of injuries by ride type is associated with power operated rides. Accidents of this type usually occur because a rider is able if they so wish to place themselves in a potentially dangerous position.

There was one fatal accident in 1999/00 that involved a member of the public and occurred on a roller coaster located in a fixed amusement park.

The safety restraint failed on a Hi impact ride situated at a travelling fair while the ride was in motion. On application of a brake to stop the ride, 14 passengers were injured, 4 of whom as a result from falling from the ride.

A stainless steel restraint on a brand new Cyclone Twist failed after approximately 5 rides. Two passengers were thrown from the ride, one smashed through the crowd barrier and was thrown clear; the other was ejected onto the decking and was crushed by the next set of cars - being pushed around the decking until the ride came to a halt receiving near fatal injuries.

In 1999/00 there were a total of 49 notices issued by the HSE; 15 improvement notices and 34 prohibition notices were issued under Section 2 or Section 3 of the Health and Safety at Work Act 1974.

6.1.6.12 Main Cause Groups for Accidents 2000/2001*

Provisionally, to date during the period 2000/01 there have been five fatalities arising from four fatal accidents at fairgrounds. All fatalities occurred on power operated rides.

Two accidents occurred at travelling fairs over the late May Bank Holiday. In one of these incidents a member of the public died when they fell out of a Top Spin ride and in the other, two members of the public died when the car of the super trooper ride they were travelling in came off the ride. A member of the public died when they received crushing injuries from the car of a swinging gym ride. A member of the public died when they fell from a car of a space invader (dark ride) roller coaster at a fixed amusement park.

In 2000/01 there were a total of 35 notices issued by the HSE; 10 improvement notices and 24 prohibition notices were issued under Section 2 or Section 3 of the Health and Safety at Work Act 1974 and 1 notice was issued under Section 6.

* Based on current year since 1 April 2000.

6.2 Numerical Risk Assessment of Fairground Rides

6.2.1 Introduction and Usage Statistics

The accident data from Sections 6.1.2 and 6.1.3 has been combined with estimates of ride usage to provide a set of numerical risk assessments in terms of various units of usage which might be convenient for comparison purposes.

The usage quantities for the numerical risk assessments are as follows:

	Travelling Fairground*	Fixed Site Amusement Parks**	Total
Number of fairgrounds in operation	300	75	375
Total number of UK fairground rides per year	5×10^8	5.0×10^8	1.0×10^9
Number of ride units in operation (all types including juvenile rides)	3100	1400	4500
Typical ride duration (minutes)	2 - 5	1.5 – 2	3 (average)
Number of Cyclone Twists in operation	194	4	198
Number of Waltzers in operation	168	23	191
Typical number of rides per person in one "session"	5-10	12	10 (average)
Number of employees associated with ride (continuous exposure equivalent man-years)	2	1.25	1.6 (average)

*Information provided by Showmans Guild of Great Britain based on their members
** Information provided by The British Association of Leisure Parks, Piers and Attraction based on their members.

6.2.2 Probability of Accident per Passenger-Ride (average over all rides)

The probability of an accident per passenger ride corresponds to the average accident rate divided by the total number of rides per year. Using the date calculated in sections 6.1.2 and 6.1.3 the probability of fatal and major accidents per passenger ride can be determined.

Over the 12 period covered by this report (1989/90 – 2000/01), the accident rate resulting in a fatality was determined in Section 6.1.4 to be 1.2 per year to members of the public. Therefore the probability per ride of a fatal accident over this period is:

$1.2 / 1 \times 10^9$ = **1.2×10^{-9} K**

For the 7 year period covering 1989/90 to 1995/96, the probability of a member of the public being killed or suffering a major injury per ride is:

$100 / 1 \times 10^9$ = **1.0×10^{-7} KMI**

For period 1996/97 to 1999/00, the average accident rate of accidents, which resulted in major injury to members of the public, was 431 per year. The probability per ride of a major injury accident over this period:

$431 / 1x10^{9}$ = **4.3×10^{-7} KMI**

6.2.3 Probability of Accident per Passenger-Second (average over all rides)

The probability of an accident per passenger second is calculated by dividing the total number of accidents by the total time (excluding unloading and loading) passengers spend on all ride types per year.

For the 12 year period covered by this report the probability of a fatal accident per passenger second is:

$0.8 / (1x10^{9} \times 180)$ = **6.7×10^{-12} K/Sec**

For the 7 year period covering 1989/90 to 1995/96, the probability of a major accident per passenger second is:

$100 / (1x10^{9} \times 180)$ = **5.6×10^{-10} KMI/Sec**

For period 1996/97 to 1999/00, the probability of a major accident per passenger second is:

$431/ (1x10^{9} \times 180)$ = **2.4×10^{-9} KMI/Sec**

6.2.4 Probability of Accident per Passenger-Session (average over all rides)

The risk per session can be compared with that of a morning or an afternoon spent horse riding, cycling, swimming or other similar leisure pursuits.

For the purposes of this report it is assumed that 10 rides will equate to a "session".

Then the probability of accident per session is as follows:

Over the 12 year period covered by this report, the probability of a fatal accident in one session is:

$1.2 \times 10^{-9} \times 10$ = **1.2×10^{-8} K**

For the 7 year period covering 1989/90 to 1995/96, the probability of a major accident in one session is:

$1.0 \times 10^{-7} \times 10$ = **1.0×10^{-6} KMI**

For period 1996/97 to 1999/00, the probability of a major accident in one session is:

$4.3 \times 10^{-7} \times 10$ = **4.3×10^{-6} KMI**

6.2.5 Probability of Accidents to Fairground Staff

The number of equivalent full-time staff exposed to accidents on the rides is assumed to be 1.6 staff per ride, which gives 7200 staff-years in total. It is expected that more staff in total will have some association with rides in any one year, but that the figure above represents the number of highly exposed staff (e.g. ride attendants and 'on line' maintenance staff).

Using the risk of death for a fairground employee calculated in Section 6.1.4, the measure of risk per staff year, over the 12 year period covered by this report is determined as follows:

$0.3K / 7200$ = **3.5×10^{-5} K per year**

For the period covering 1989/90 to 1995/96, using the average accident rate calculated in Section 6.1.5 for accidents resulting in a fairground employee being killed or suffering major injury, the measure of risk per staff year is:

13.4 KMI / 7200 = **1.9×10^{-3} KMI per year**

Conversely, over the period 1996/97 to 1999/00, the measure of risk per staff year is:

43.3 KMI / 7200 = **6.0×10^{-3} KMI per year**

6.2.6 Uncertainties in the Risk Estimates

The uncertainties in the risk estimates derive from the true statistical variability due to limited sampling, and from uncertainty in the usage data. It would be wise to consider at least a factor of two uncertainty either way in conjunction with the above estimates.

6.3 Comparative Risks from Other Activities

The following section gives comparative risks from a sample of other activities undertaken by the general public which might be considered comparable in some respect to riding fairground attractions. The first compariator is the risk in travelling to and from the fairground by a motor car, and the remainder covers a variety of other activities.

In the following section, risks are expressed in terms of Killed (K) and Killed or Seriously injured (KSI) where serious injury is defined as an injury for which a person is detained in hospital as an 'in-patient', or any of the following injuries whether or not they are detained in hospital; fractures, concussion, internal injuries, crushings, severe cuts, and lacerations, severe shock requiring medical treatment, injuries causing death 30 days or more days after the accident.

The RIDDOR 95 categorisation of a reportable major injury includes; fractures other than to the fingers, thumbs or toes, amputations, dislocation of the shoulder, hip knee or spine etc and accidents which result in a member of the public is sent to hospital for treatment.

As a result of the requirement to report accidents that require hospital treatment under RIDDOR 95, a number of relatively minor accidents (which cannot be quantified) are included in the calculated risks of being killed or suffering major injury (KMI) on fairground rides. Statistics for other compariator activities generally relate to being killed or seriously injured (KSI) and are therefore not directly comparable with the KMI calculated for fairground rides. However, for illustrative purposes it is considered appropriate to make a comparison so as to provide an indication of the relative risks associated with fairground rides and some other activities.

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6.3.1 Risk of Travelling to and from a Fairground in a Motor Vehicle

This section considers the risk of travelling in a motor car to a fair using a mixture of typical A, B and C class roads as well as motorways.

From the Transport Statistics Great Britain 1999 Edition the average risk over all road usage for period 1988-1997 is as follows:

The risk of being killed	=	4 K	per	1×10^9 km
The risk of being killed or seriously injured:	=	46 KSI	per	1×10^9 km

Assuming the distance to the fairground is 30 km (each way), the probability of being killed or seriously injured whilst travelling a distance of 60 km by car is as follows:

$(60 \times 46)/10^9$ = **2.8×10^{-6} KSI**

$(60 \times 4)/10^9$ = **2.4×10^{-7} K**

6.3.2 Risk of Travelling in a Motor Vehicle (as a Function of Time)

The risk of travelling in a motor vehicle can be estimated as a risk per second.

For average road use, it is assumed that a vehicle has an average speed of 60 km/hr, and the risk of being killed or seriously injured (KSI) is 46 x 10^{-9} per km and the risk of being killed (K) is 4 x 10^{-9}, producing a risk of approximately:

7.7 x 10^{-10} KSI/Sec

6.7 x 10^{-11} K/Sec

This fatal risk is considerably higher than the average risk per second on a fairground ride.

6.3.3 Risk of Riding Two Wheeled Motor Vehicle

The average risk of riding a two wheeled motor vehicle over period 1988-1997 is as follows:

The risk of being killed	= 90 K	per	1 x 10^9 km
The risk of being killed or seriously injured	= 1441 KSI	per	1 x 10^9 km

Again, assuming the fairground is 30 km each way, the probability of being killed or seriously injured over distance of 60 km is:

60 x 1441/10^9 = **8.7 x 10^{-5} KSI**

60 x 90/10^{-9} = **5.4 x 10^{-6} K**

6.3.4 Risk of Riding a Two Wheeled Motor Vehicle (as a Function of Time)

The risk of riding a two wheeled motor vehicle can also be estimated as risk per second.

For average road use on a motor cycle, it is assumed that a vehicle has an average speed of 60 km/hr, the risk of being killed (K) is 90 x 10^{-9} and the risk of being killed or seriously injured (KSI) is 1441 x 10^{-9} per km, producing a risk per second of approximately:

1.5 x 10^{-9} K/Sec

2.4 x 10^{-8} KSI/Sec

6.3.5 Risk of Pedal Cycling

Cycle riding is an almost universal activity amongst young people who account for the majority of people who attend fairgrounds. Although it is not perceived as an activity with particularly high risks attached, the accident statistics indicate that the risks are higher than those of car driving, and are approximately half (in terms of risks per km travelled) of those associated with motor-cycling where there is a very substantial perception of risk attached.
The average risk of riding a pedal cycle in the period 1988-1997 is as follows:

The risk of being killed	= 46 K	per	1 x 10^9 km
The risk of being killed or seriously injured:	= 885 KSI	per	1 x 10^9 km

Assuming an average speed of 20 km/hr the risk per second of the cycling activity is as follows:

2.6 x 10^{-10} K/Sec

4.9 x 10^{-9} KSI/Sec

Therefore the risk of being killed or seriously injured per second pedal cycling is approximately equal to that from fairground riding. The risk of being killed is substantially higher (over an order of magnitude) than the risks per second from fairground riding. If the higher proportion of cycling accidents amongst young persons and the longer continuous exposure times (in a "session") were taken into account, then it is apparent that cycle riding on roads has a very much higher risk attached, compared to fairground riding.

6.3.6 Risk of Walking to a Fair

Since walking to a fair would involve a risk to the person undertaking the walk, it is possible to compare the risk of being killed or seriously injured en route with that of the fairground ride session for which the walk was initiated.

The average risk of walking in the period 1988-1997 is as follows:

The risk of being killed	= 68 K	per	1×10^9 km
The risk of being killed or seriously injured:	= 726 KSI	per	1×10^9 km

Therefore, in terms of distance travelled, a pedestrian is estimated to be roughly seventeen times as likely to be killed in a road accident as a car occupant.

Assuming that the length of walk to the fair is 1 km each way (figure based on the average length of walk journey 1996/98), the risk of being killed and the risk of being killed or seriously injured walking to the fair are 1.4×10^{-7} K and 1.5×10^{-6} KSI respectively.

In a more generalised case, using the assumption that walking to the fair would involve a person in half the average daily exposure to risk as a pedestrian, it is again possible to compare the risk of walking to the fair with that of a fairground ride session. The total distance walked in 1996/1998 was approximately 311 km per person. This relates to a risk of being killed of 2.1×10^{-5} per year, which in half a day becomes 2.9×10^{-8} K.

Therefore in both instances the risk is higher than the estimated 8×10^{-9} for 10 fairground rides. Of course, due to uncertainties in both estimates there is only rough comparability rather than an exactly known ratio. Similar comparability exists between risks of serious injury in the activities at a fair and the pedestrian journey to and from a fair.

6.3.5 Risk of Horse Riding

Horse riding, although a minority, and somewhat "upper class" sport (in contrast to fairground riding, which has no such aristocratic heritage), may be thought to provide some experiences similar to those of fairground riding.

There were 4 fatalities involving horse riding reported to the HSE Field Operations Directorate, over the 10 year period (1990 – 1999).

The adult population of England and Wales is say 43 million.

The average number of occasions of participating adult per year 0.6.
Therefore the probability of being killed during one session of horse riding is:

$4/(43 \times 10^6 \times 0.6 \times 10) = \mathbf{1.6 \times 10^{-8}\ K}$

As the other calculations indicate, travel by car, cycle or horse would involve higher risks than walking. Travel by public transport would involve lower risks (Pedestrians are over 150 times more likely to be killed per kilometre travelled than bus or coach passengers). However compared to the previous version of this report, since 1988 the rate of both killed and killed or seriously injured accidents for the above comparative activities have typically decreased annually, despite the continuous growth in road traffic.

6.3.7 Other Individual Risks

Data exists on a variety of individual risks to UK individuals. The data normally refers to a calendar year. In this report, a comparator for these figures is a person who takes 100 fairground rides in a year (i.e. 10 sessions), whose individual risk due to fairground rides would then be as follows:

4.3×10^{-5}	KMI	(1996/97 – 1999/00)
8×10^{-8}	K	

A list of individual risks of death follows:

Lightning	8×10^{-8}	K
Excessive cold		6×10^{-7} K
Fire[4]		1×10^{-5} K
Pedestrian Road Accidents	[5]	1.8×10^{-5} K
All Road Users[5]		5.7×10^{-5} K
Home accidents[6]		5.7×10^{-5} K

As can be seen, the risk, even to a reasonably regular fairground rider, is at the lower end of the range of listed individual risks.

[4] Fire Statistics United Kingdom 1999. Issue 20/00. 8 November 2000
[5] Transport Statistics Great Britain 1999 Edition. Department of the Environment, Transport and the Regions.
[6] Home Safety Network. Department of Trade and Industry Figures. 1995 data.

7 APPENDIX 2 (NOT UPDATED)

FURTHER DETAILS ON DEFENCES

8 APPENDIX 3 (NOT UPDATED)

SUMMARY REPORTS ON SITE VISITS

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