

Accident Analysis  
Roller Coasters

## 1. Introduction

Accident analysis consists of gathering accident information on similar types of equipment and determining the proximate cause of the accident. This information is then used as a design constraint for new systems.

## 2. Source

The information in this assessment was taken from the Rides911 website, which collects information on amusement park accidents. In combination with data from the CPSC, which is also on this website, these incidents go back to 1972. Early information from the CPSC is sketchy, and does not contain much detail. Later CPSC information, and the Rides911 data which is taken from newspaper reports, is more complete. This information was collected on 7/27/01.

## 3. Data

<b>Incident:</b>	<b>Vehicle Collision/Control System Failure</b>
Park:	Jazzland
Date:	7/24/01
Information Source:	Rides911
Failure Cause:	Operator error
Contributing Factors:	None
Injuries	Minor
Comments	Reports attribute accident to operator error, however system should be able to prevent operator errors from allowing incidents.

<b>Incident:</b>	<b>Vehicle Collision/Control System Failure</b>
Park:	Branson USA
Date:	6/21/01
Information Source:	Rides911
Failure Cause:	Operator error
Contributing Factors:	None
Injuries	Minor
Comments	Reports attribute accident to operator error, however system should be able to prevent operator errors from allowing incidents.

<b>Incident:</b>	<b>Derailment/Train Failure</b>
Park:	Myrtle Beach Pavilion
Date:	7/21/01
Information Source:	Rides911
Failure Cause:	Faulty assembly
Contributing Factors:	None
Injuries	Minor
Comments	None

<b>Incident:</b>	<b>Vehicle Collision/Unknown</b>
Park:	Lightwater Valley
Date:	6/21/01
Information Source:	Rides911
Failure Cause:	Unknown
Contributing Factors:	None
Injuries	Death, serious injuries

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Comments	None
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<b>Incident:</b>	<b>Person/Vehicle Collision</b>
Park:	Lake Compounce
Date:	6/13/01
Information Source:	Rides911
Failure Cause:	Operation
Contributing Factors:	Failure to give notice of operation
Injuries	Death
Comments	

<b>Incident:</b>	<b>Ride Related Death</b>
Park:	Six Flags Magic Mountain
Date:	6/2/01
Information Source:	Rides911
Failure Cause:	No ride failure
Contributing Factors:	Medical Condition
Injuries	Death
Comments	Ride related, not due to a failure of the ride

<b>Incident:</b>	<b>Derailment/Vehicle Failure</b>
Park:	Six Flags Fiesta Texas
Date:	5/28/01
Information Source:	Rides911
Failure Cause:	Broken hitch
Contributing Factors:	None
Injuries	Minor
Comments	None

<b>Incident:</b>	<b>Derailment/Vehicle Failure</b>
Park:	Fujikyu Highland
Date:	5/6/01
Information Source:	Rides911
Failure Cause:	Axle failure
Contributing Factors:	None
Injuries	Serious
Comments	None

<b>Incident:</b>	<b>Fire</b>
Park:	Phantasialand
Date:	5/1/01
Information Source:	Rides911
Failure Cause:	Wiring
Contributing Factors:	None
Injuries	Multiple injuries, nature not known
Comments	None

<b>Incident:</b>	<b>Unknown</b>
Park:	Unknown in Bristol CN
Date:	7/19/81
Information Source:	CPSC Files

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Failure Cause:	Unknown
Contributing Factors:	Unknown
Injuries	Death
Comments	None

<b>Incident:</b>	<b>Vehicle Collision/Brake Failure</b>
Park:	Blackpool Pleasure Beach
Date:	8/31/00
Information Source:	Rides911
Failure Cause:	Brake Failure
Contributing Factors:	None
Injuries	Serious
Comments	Causal information from ride manufacturer

<b>Incident:</b>	<b>Restraint Failure</b>
Park:	Unknown in Chenmitz Germany
Date:	7/23/00
Information Source:	Rides911
Failure Cause:	No restraint in use
Contributing Factors:	Guest may have been kneeling in seat
Injuries	Death
Comments	None

<b>Incident:</b>	<b>Restraint Failure</b>
Park:	Blackpool Pleasure Beach
Date:	7/22/00
Information Source:	Rides911
Failure Cause:	Unknown
Contributing Factors:	None
Injuries	Death
Comments	None

<b>Incident:</b>	<b>Restraint Failure</b>
Park:	Michigan's Adventure
Date:	6/30/00
Information Source:	Rides911
Failure Cause:	Unknown
Contributing Factors:	Guest action
Injuries	Serious injuries
Comments	None

<b>Incident:</b>	<b>Restraint Failure</b>
Park:	Thorpe Park
Date:	6/1/00
Information Source:	Rides911
Failure Cause:	Unknown
Contributing Factors:	None
Injuries	Serious injuries
Comments	None

<b>Incident:</b>	<b>Operator Injury</b>
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Park:	Six Flags Ohio
Date:	5/30/00
Information Source:	Rides911
Failure Cause:	Operator error
Contributing Factors:	None
Injuries	Minor
Comments	None

<b>Incident:</b>	<b>Vehicle Collision/Vehicle Failure</b>
Park:	Geauga Lake
Date:	9/26/99
Information Source:	Rides911
Failure Cause:	Broken hitch
Contributing Factors:	None
Injuries	Minor
Comments	None

<b>Incident:</b>	<b>Vehicle Collision/Lift Failure</b>
Park:	Gillian's Wonderland Pier
Date:	8/28/99
Information Source:	Rides911
Failure Cause:	Chain dog failure
Contributing Factors:	Anti rollback system failure
Injuries	Two deaths
Comments	Anti rollback system modified by owner/operator

<b>Incident:</b>	<b>Restraint Failure</b>
Park:	Paramount's Kings Dominion
Date:	8/23/99
Information Source:	Rides911
Failure Cause:	Passenger misconduct
Contributing Factors:	
Injuries	1 death
Comments	None

<b>Incident:</b>	<b>Falling Object</b>
Park:	Knott's Berry Farm
Date:	8/23/99
Information Source:	Rides911
Failure Cause:	Falling object
Contributing Factors:	None
Injuries	Minor
Comments	none

<b>Incident:</b>	<b>Derailment/Track Failure</b>
Park:	World's of Fun
Date:	7/17/99
Information Source:	Rides911
Failure Cause:	Metal Fatigue
Contributing Factors:	None
Injuries	Minor

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Comments	None
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<b>Incident:</b>	<b>Vehicle Collision/Control System Failure</b>
Park:	Kennywood
Date:	7/8/99
Information Source:	Rides911
Failure Cause:	Control system failure
Contributing Factors:	Operator error
Injuries	Minor
Comments	Control system reported to be minimal. Most of the responsibility was on the operator.

<b>Incident:</b>	<b>Restraint Failure</b>
Park:	Six Flags Darien Lake
Date:	5/16/99
Information Source:	Rides911
Failure Cause:	Passenger exceeded restraints capacity
Contributing Factors:	
Injuries	Minor
Comments	Operating issue

<b>Incident:</b>	<b>Vehicle Collision/Control System Failure</b>
Park:	Paramount's Carowinds
Date:	4/5/99
Information Source:	Ride911
Failure Cause:	Sensor failure
Contributing Factors:	Control system latent error, Braking system condition,
Injuries	Minor
Comments	Speed control should be considered in hazard analysis

<b>Incident:</b>	<b>Derailment/Overspeed</b>
Park:	Clementon Lake Amusement Park
Date:	8/5/98
Information Source:	Rides911
Failure Cause:	Operator error
Contributing Factors:	Control system design allowed override
Injuries	Minor
Comments	

<b>Incident:</b>	<b>Person/Vehicle Collision</b>
Park:	Paramount's Great America
Date:	9/7/98
Information Source:	Rides911
Failure Cause:	Guest misconduct
Contributing Factors:	
Injuries	1 death, serious injuries
Comments	

<b>Incident:</b>	<b>Vehicle Collision/Vehicle Failure</b>
Park:	North Carolina State Fair
Date:	10/17/98

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Information Source:	Rides911
Failure Cause:	Mechanical Failure
Contributing Factors:	Inadequate block system
Injuries	Minor
Comments	

<b>Incident:</b>	<b>Person/Vehicle Collision</b>
Park:	Six Flags Astroworld
Date:	8/9/97
Information Source:	CPSC files
Failure Cause:	Lockout/Tagout procedure
Contributing Factors:	
Injuries	1 death
Comments	Operating issue

<b>Incident:</b>	<b>Person/Vehicle Collision</b>
Park:	Unknown
Date:	8/2/97
Information Source:	CPSC files
Failure Cause:	Lockout/Tagout procedure
Contributing Factors:	
Injuries	1 death
Comments	Operating issue

<b>Incident:</b>	<b>Vehicle Collision/Lift Failure</b>
Park:	Bell's Amusement Park
Date:	4/20/97
Information Source:	CPSC files
Failure Cause:	Chain dog failure
Contributing Factors:	Rollback system failure
Injuries	Death, serious injury
Comments	

<b>Incident:</b>	<b>Person/Vehicle Collision</b>
Park:	Six Flags Magic Mountain
Date:	5/30/96
Information Source:	CPSC files
Failure Cause:	Train crossing procedure
Contributing Factors:	
Injuries	1 death
Comments	Operating issue

<b>Incident:</b>	<b>Person/Vehicle Collision</b>
Park:	Morey's Pier
Date:	8/14/95
Information Source:	CPSC files
Failure Cause:	Lockout/Tagout procedure
Contributing Factors:	
Injuries	1 death, 1 injury
Comments	Operating issue

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<b>Incident:</b>	<b>Restraint Failure</b>
Park:	Worlds of Fun
Date:	6/30/95
Information Source:	CPSC files
Failure Cause:	Unknown
Contributing Factors:	Guest may have been kneeling
Injuries	1 death
Comments	None

<b>Incident:</b>	<b>Unknown</b>
Park:	Cedar Point
Date:	5/28/94
Information Source:	CPSC Files
Failure Cause:	Unknown
Contributing Factors:	Unknown
Injuries	Death
Comments	CPSC file did not contain any further information

<b>Incident:</b>	<b>Restraint Failure</b>
Park:	Lagoon
Date:	6/9/89
Information Source:	CPSC files, personal recollection
Failure Cause:	Passenger misconduct
Contributing Factors:	Restraint design (single lap bar)
Injuries	1 death
Comments	None

<b>Incident:</b>	<b>Person/Vehicle Collision</b>
Park:	Lagoon
Date:	4/30/89
Information Source:	CPSC files, personal recollection
Failure Cause:	Passenger error, operator error
Contributing Factors:	Restraint system
Injuries	1 death
Comments	None

<b>Incident:</b>	<b>Restraint Failure</b>
Park:	Astroland
Date:	8/23/88
Information Source:	CPSC Files
Failure Cause:	Restraint failure
Contributing Factors:	Guest misconduct
Injuries	Death
Comments	None

<b>Incident:</b>	<b>Restraint Failure</b>
Park:	Great Adventure
Date:	6/17/87
Information Source:	CPSC Files
Failure Cause:	Operations Error, Guest not restrained

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Contributing Factors:	None
Injuries	Death
Comments	None

<b>Incident:</b>	<b>Restraint Failure</b>
Park:	Unknown in New Jersey
Date:	5/16/87
Information Source:	CPSC Files
Failure Cause:	Restraint Failure
Contributing Factors:	Guest stood up
Injuries	Death
Comments	None

<b>Incident:</b>	<b>Restraint Failure</b>
Park:	Lincoln Park
Date:	8/17/86
Information Source:	CPSC Files
Failure Cause:	Restraint Failure
Contributing Factors:	Guest stood up
Injuries	Death
Comments	None

<b>Incident:</b>	<b>Operator Injury</b>
Park:	Unknown in El Paso Texas
Date:	9/1/85
Information Source:	CPSC Files
Failure Cause:	Unknown
Contributing Factors:	Unknown
Injuries	Serious
Comments	None

<b>Incident:</b>	<b>Person/Vehicle Collision</b>
Park:	Unknown in Baton Rouge Louisiana
Date:	6/2/85
Information Source:	CPSC Files
Failure Cause:	Unknown
Contributing Factors:	Unknown
Injuries	Death
Comments	None

<b>Incident:</b>	<b>Restraint Failure</b>
Park:	Astroland
Date:	5/26/85
Information Source:	CPSC Files
Failure Cause:	Restraint Failure
Contributing Factors:	Guest stood up
Injuries	Death
Comments	None

<b>Incident:</b>	<b>Restraint Failure</b>
Park:	Unknown in Minot ND

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Date:	7/28/84
Information Source:	CPSC Files
Failure Cause:	Restraint Failure
Contributing Factors:	None
Injuries	Death
Comments	None

<b>Incident:</b>	<b>Restraint Failure</b>
Park:	Six Flags over Mid-America
Date:	7/7/84
Information Source:	CPSC Files
Failure Cause:	Restraint Failure
Contributing Factors:	None
Injuries	Death
Comments	None

<b>Incident:</b>	<b>Restraint Failure</b>
Park:	Unknown in Myrtle Beach
Date:	4/3/84
Information Source:	CPSC Files
Failure Cause:	Restraint Failure
Contributing Factors:	None
Injuries	Death
Comments	None

<b>Incident:</b>	<b>Restraint Failure</b>
Park:	Disneyland
Date:	1/3/84
Information Source:	CPSC Files
Failure Cause:	Restraint Failure
Contributing Factors:	None
Injuries	Death
Comments	None

<b>Incident:</b>	<b>Unknown</b>
Park:	Kings Dominion
Date:	9/10/83
Information Source:	CPSC Files
Failure Cause:	Head struck object
Contributing Factors:	None
Injuries	Death
Comments	From information, it is not possible to determine if this is a Ride Envelope problem or a Falling Object.

<b>Incident:</b>	<b>Restraint Failure</b>
Park:	Six Flags Great Adventure
Date:	8/16/81
Information Source:	CPSC Files
Failure Cause:	Restraint Failure
Contributing Factors:	Operation
Injuries	Death

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Comments	Operator during test run, may have not secured restraint.
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<b>Incident:</b>	<b>Restraint Failure</b>
Park:	Unknown in Bristol CN
Date:	7/19/81
Information Source:	CPSC Files
Failure Cause:	Unknown
Contributing Factors:	Unknown
Injuries	Death
Comments	None

<b>Incident:</b>	<b>Restraint Failure</b>
Park:	Unknown in Denver Colorado
Date:	7/19/81
Information Source:	CPSC Files
Failure Cause:	Unknown
Contributing Factors:	Unknown
Injuries	Death
Comments	None

<b>Incident:</b>	<b>Unknown</b>
Park:	Nashville TN
Date:	7/30/80
Information Source:	CPSC Files
Failure Cause:	Unknown
Contributing Factors:	Unknown
Injuries	Death
Comments	None

<b>Incident:</b>	<b>Transfer System</b>
Park:	Missouri
Date:	7/9/80
Information Source:	CPSC Files
Failure Cause:	Operator Error
Contributing Factors:	Low clearance in transfer area
Injuries	Death
Comments	None

<b>Incident:</b>	<b>Ride Related Death</b>
Park:	Orlando FL
Date:	6/80
Information Source:	CPSC Files
Failure Cause:	No ride failure
Contributing Factors:	Medical condition
Injuries	Death
Comments	None

<b>Incident:</b>	<b>Person/Vehicle Collision</b>
Park:	Great America
Date:	3/29/80
Information Source:	CPSC Files

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Failure Cause:	Unknown
Contributing Factors:	Unknown
Injuries	Death
Comments	None

<b>Incident:</b>	<b>Fall</b>
Park:	Salisbury Beach MA
Date:	7/25/73
Information Source:	CPSC Files
Failure Cause:	Unknown
Contributing Factors:	Unknown
Injuries	Death
Comments	Death as listed as fall, but may not be due to operation of ride

#### 4. Results

Hazard		Occurrences
Restraint Failure		20
Person/Vehicle collision		9
Vehicle Collision		11
Vehicle Collision/Control System Failure	4	
Vehicle Collision/Lift Failure	2	
Vehicle Collision/Vehicle Failure	2	
Vehicle Collision/Brake Failure	2	
Vehicle Collision/Unknown	1	
Derailment		6
Derailment/Vehicle Failure	3	
Derailment/Track Failure	2	
Derailment/Overspeed	1	
Ride Related Death		2
Fire		1
Operator Injury		2
Falling Object		1
Transfer		1
Unknown		3

The ride related deaths could not have been prevented by any action of the ride system, and so are not included as a controllable hazard. The derailment and collision categories are grouped to show the number of such incidences, but then split to show different causes.

#### 5. Conclusion

The amusement device shall be designed for the following hazards:

1. Restraint Failures
2. Collisions.
3. Derailment
4. Fire
5. Injury to operators by equipment
6. Falling Objects
7. Improper use of transfer mechanism