

Inflatable Amusement Ride Safety

An Interactive Qualifying Project Proposal
Submitted to the Faculty
Of the
WORCESTER POLYTECHNIC INSTITUTE
In partial fulfillment of the requirements for the
Degree of Bachelor of Science
by

Joseph Sceviour

Jennifer Hosker

Courtney Hardy

In partnership with the United States
Consumer Product Safety Commission.

In cooperation with:

Mark Kumagai
Director, ESME
Directorate for Engineering Sciences

Professor El-Korchi, Co-Advisor

Professor Servatius, Co-Advisor

Unless otherwise stated, any views or opinions expressed in this report are solely those of the authors and do not necessarily represent those of the U.S. Consumer Product Safety Commission or Worcester Polytechnic Institute.

Submitted on: 1/11/2006

Abstract

This report, prepared for the U.S. Consumer Product Safety Commission (CPSC) of Washington, D.C., outlines our approach to investigating the increase in injuries related to inflatable amusement rides. Using data from surveys, interviews, injury databases, archival research, and product testing, we completed three goals: We developed a five category system to classify inflatable amusement rides; determined ways the CPSC and other involved parties can improve the safety of inflatable rides; and recommended how future CPSC investigations can be handled.

Acknowledgements

We would like to thank the people and organizations who have aided us in this project: our advisors Professor Tahar El-Korchi and Professor Brigitte Servatius, Professor David Dibiasio, Chuck Ackerman, Dave Shibilina, Google.com, many state officials and trade organizations, Worcester Polytechnic Institute, the U.S. Consumer Product Safety Commission, and everyone else who took the time to talk to us. Most of all we would like to thank our liaison CPSC Director of Mechanical Engineering Mark Kumagai for all his time and help. We have greatly appreciated everyone's efforts which contributed so much to our project.

Table of Contents

<u>LIST OF FIGURES</u>	8
<u>LISTS OF TABLES</u>	9
<u>1. EXECUTIVE SUMMARY</u>	10
<u>2. DEFINITION OF THE PROBLEM</u>	12
<u>2.1 WHAT ARE INFLATABLE AMUSEMENT RIDES: DEFINITION AND CATEGORIES</u>	13
<u>2.2 THE INFLATABLE AMUSEMENT INDUSTRY</u>	16
<u>2.3 RECENT CPSC ACTIVITY</u>	18
<u>2.4.a PROJECT GOALS</u>	18
<u>2.4.b FULFILLING THE IQP REQUIREMENT/ QUALIFYING AS AN IQP</u>	19
<u>3. INJURY DATA</u>	21
<u>3.1 FATALITIES</u>	21
<u>3.2 INJURY DATA OBTAINED FROM DATABASES</u>	22
<u>3.3 SEARCH CRITERIA USED FOR DATABASE ANALYSIS</u>	23
<u>3.4 RESULTS FROM DATABASE ANALYSIS</u>	25
<u>4. ENVIRONMENTAL AND HUMAN CAUSES FOR INJURY</u>	32
<u>4.1 ENVIRONMENTAL – WIND AND RAIN</u>	32
<u>4.2a OVERCROWDING</u>	32
<u>4.2.b OPERATOR ERROR</u>	33
<u>4.2.c OTHER CAUSES</u>	34
<u>5. SURVEYS</u>	36
<u>6. INTERVIEWS</u>	38

<u>6.1 TRADE ORGANIZATIONS</u>	38
<u>6.2 STATE OFFICIALS</u>	41
<u>6.3 MISCELLANEOUS INTERVIEWS</u>	45
<u>7. ONLINE FORUM: AIRCO MOONWALK RENTAL FORUM</u>	47
<u>7.1 WHAT RENTAL COMPANIES CAN OFFER A CONSUMER</u>	48
<u>7.2 SETUP AND SUPERVISION</u>	53
<u>7.3 FINANCIAL MATTERS</u>	55
<u>7.4 INSURANCE</u>	57
<u>8. USAGE NUMBERS</u>	61
<u>9. REGULATIONS/ LEGISLATION/ STATEMENTS</u>	62
<u>10. LAWSUITS</u>	66
<u>11. HOME USE INFLATABLES</u>	68
<u>11.1 THE POTENTIAL DANGERS OF HOME USE INFLATABLES</u>	68
<u>12. GROUND FAULT CIRCUIT INTERRUPTERS</u>	70
<u>13. STANDARDS</u>	72
<u>13.1 UL STANDARDS</u>	73
<u>13.2 ASTM STANDARDS</u>	74
<u>14. CONSUMER EDUCATION</u>	78
<u>15. APPLYING PLAYGROUND SAFETY TO INFLATABLE AMUSEMENTS</u>	79
<u>15.1 USE ZONE</u>	79
<u>15.2 CRITICAL HEIGHT</u>	79
<u>15.3 GUARD RAILS</u>	80
<u>15.4 ENTRAPMENT</u>	81

<u>16. SUMMARY OF RECOMMENDATIONS FOR A SAFER INFLATABLE</u>	
<u>AMUSEMENT INDUSTRY</u>	82
<u>17. FUTURE REFERENCE</u>	84
<u>18. REFERENCES</u>	85
<u>19. BIBLIOGRAPHY</u>	91
<u>APPENDIX A: HISTORY OF CPSC</u>	100
<u>APPENDIX B: MAP OF HOSPITALS REPORTING TO NEISS</u>	102
<u>APPENDIX C: TABLE: MONTHLY BREAKDOWN OF INJURIES FOR INFLATABLE RIDES FROM 1997 TO 2001</u>	103
<u>APPENDIX D: TABLE: BREAKDOWN OF INJURIES FOR INFLATABLE RIDES FROM 1997 TO 2001 BY AGE AND GENDER</u>	104
<u>APPENDIX E: TABLE: BREAKDOWN OF INJURIES FOR INFLATABLE RIDES FROM 1997 TO 2001 BY BODY PART AND DIAGNOSIS</u>	105
<u>APPENDIX F: TABLE: BREAKDOWN OF INJURIES FOR INFLATABLE RIDES FROM 1997 TO 2001 BY DISPOSITION</u>	106
<u>APPENDIX G: SURVEY: MANUFACTURERS</u>	107
<u>APPENDIX H: SURVEY: RENTAL COMPANIES</u>	111
<u>APPENDIX I: SURVEY: STATE OFFICIALS</u>	115
<u>APPENDIX J: SURVEY: TRADE ASSOCIATIONS</u>	116
<u>APPENDIX K: GFCI INFORMATION</u>	119
<u>APPENDIX L: UL LISTING CORRESPONDENCE</u>	123

List of Figures

[Figure 1: Yearly Estimates of Injuries Related to Inflatable Attractions from 1997 to 2004 in U.S.](#)

[Figure 2: Bounce House](#)

[Figure 3: Inflatable Slide](#)

[Figure 4: Bungee Run](#)

[Figure 5: Inflatable Boxing Attraction](#)

[Figure 6: Inflatable Jousting Attraction](#)

[Figure 7: Inflatable Obstacle Course](#)

[Figure 8: Inflatable Climbing Wall](#)

[Figure 9: Inflatable Industry](#)

[Figure 10: Estimated Number of Injuries per Age Group from 1987 to 2004 in United States for Inflatable Attractions](#)

[Figure 11: Estimated Number of Injuries per Type of Injury from 1997 to 2004](#)

[Figure 12: Estimated Number of Injuries per Year from 1997 to 2004 in United States](#)

[Figure 13: How Many Units do you have in Your Rental Fleet?](#)

[Figure 14: Are Bounce Houses Becoming a Thing of the Past?](#)

[Figure 15: Do you own an Inflatable Boxing Attraction?](#)

[Figure 16: What do you Offer to Customers?](#)

[Figure 17: Would you buy Imported Units?](#)

[Figure 18: What Surface do you Most Commonly Setup Your Moonwalks on?](#)

[Figure 19: Do you provide Unattended Rentals to Your Customers?](#)

[Figure 20: What Month do you Make the Most Money Renting Moonwalks?](#)

[Figure 21: What Type of Events do you make the Most Money In?](#)

[Figure 22: Is Insurance really a Problem?](#)

[Figure 23: How Much Does Your Insurance Cost You Per Year?](#)

[Figure 24: Would You Still Have Started This Business if the Insurance was Priced Like it is Today?](#)

[Figure 25: Map of State Regulations](#)

[Figure 26: Home Inflatable Testing](#)

[Figure 27: Ripped Stitching on Home Inflatable](#)

[Figure 28: Portable Ground Fault Circuit Interrupter](#)

List of Tables

[Table 1: Reported Fatalities for Inflatable Attractions from 2002 to 2005](#)

[Table 2: Estimated Number of Injuries from 1987 to 2004 in United States](#)

[Table 3: Estimated Number of Injuries per Age Group from 1987 to 2004 in United States for all Inflatable Attractions](#)

[Table 4: Estimated Number of Injuries per Type of Injury from 1997 to 2004](#)

[Table 5: Estimated Number of Injuries Each Year from 1987 to 2004 in United States](#)

1. Executive Summary

Inflatable amusement attractions, defined as air-supported structures inflated by a blower unit to maintain internal air-pressure, have been involved in an increasing number of accidents. Between 1997 and 2004 the estimated number of injuries on these amusements more than tripled. Due to this spike, the Consumer Product Safety Commission (CPSC) asked our project group to research this product and the issues associated with it. The project had the following goals: categorize/ define the various inflatable amusements; make recommendations on how the CPSC can improve the safety of inflatable amusements; suggest future courses of action by CPSC.

In order to complete this project we used a variety of methods and resources. Trade magazines were read. ASTM standards and Underwriter Laboratories Inc. (UL) listings relevant to inflatable amusements were analyzed. Archival data was harvested from an online forum for inflatable rental companies. Accident reports from injury databases were analyzed. These databases included the National Electronic Injury Surveillance System (NEISS), a resource that allows users to estimate national injury numbers for a given product.

Surveys were sent to approximately two hundred people involved in the industry, including rental companies, manufacturers, state inspectors, and trade organizations. Interviews were conducted with experts in the field. CPSC employees from multiple divisions and subdivision were consulted. Finally, a sample of the product was tested.

After looking at different inflatable designs we organized them into five categories. These classifications were determined by how the amusement is used as well as what types of injuries commonly occur on them. These categories are bounce houses, slides,

obstacle courses, climbing walls, and interactive inflatables.

After completing our research we recommend that the CPSC work with the industry to make the following happen: States should consider adopting New Jersey's regulations. ASTM International should update its standards. Underwriter's Laboratory should certify blowers. Playground requirements should be adapted to fit inflatable amusements. Visible warning labels should be mandatory. The CPSC should educate consumers.

Finally, we outlined the following areas of future research that the CPSC should explore. These areas include topics our group did not have time to fully address as well as ones outside the scope of our project. They are insurance, staking and anchoring requirements, inflatable waterslides, carnivals, usage numbers, and inflatables made in foreign countries.

2. Definition of the Problem

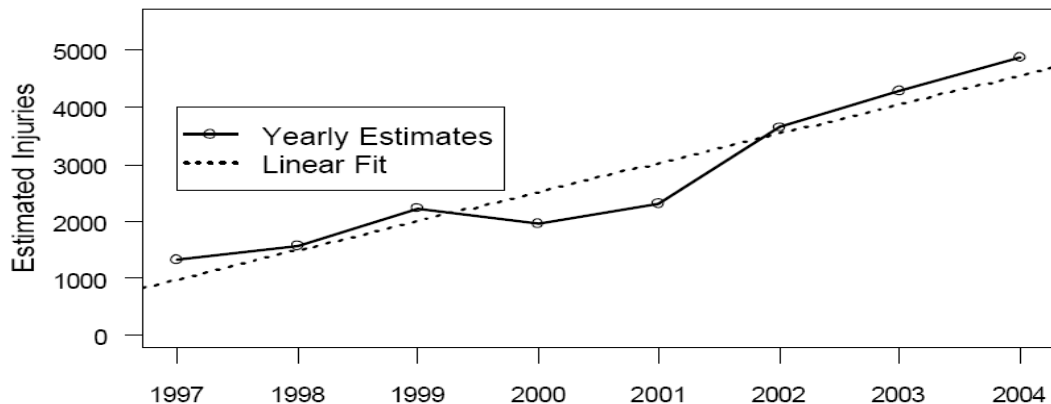
On Monday, March 11, 2001, in Kapunda, Australia the headlines read “One killed, 12 injured in inflatable ride accident.” An eight-year-old girl died and twelve others were injured after an inflatable ride detached from its grounding cables. Five of the injured parties were hospitalized. “Officials say that a strong, freak gust of wind lifted the ride about 10 feet into the air, and that they will focus their investigation on the cables used to secure the ride to the ground. (RideAccidents.com)”

This incident is not an isolated occurrence. This type of tragedy is becoming increasingly frequent for inflatable amusements. There have been four recent [fatalities](#), and over 27,000 estimated injuries in the last 17 years, according to the NEISS database.

According to the U.S. Consumer Product Safety Commission’s 2004 report on *Amusement Ride-Related Injuries and Deaths in United States*, there has been a “significant upward trend over the period from 1997 to 2004” in inflatable ride injuries (as shown in Figure 1) ([CPSC Report, 2004](#)).

Figure 1: Yearly Estimates of Injuries Related to Inflatable Attractions from 1997 to 2004 in U.S.

Figure 2: Non-Occupational, Inflatable Ride Injury Estimates.



Source: U.S. Consumer Product Safety Commission, NEISS.

2.1 What are Inflatable Amusement Rides: Definition and Categories

“Inflatable [amusement] rides are air-supported structures containing a blower unit to maintain internal air-pressure.” ([Twitchell](#)) These rides come in many shapes and sizes and have very different uses. They can be separated into five broad categories:

Bounce houses are enclosed, inflatable structures primarily used to jump up and down on. Different names for bounce houses are moonwalks, jumpers, spacewalks, and moonbounces. These are the oldest type of inflatable used in the industry. They are the most commonly used inflatable amusement and are often rented for backyard parties.

Figure 2: Bounce House



Source: <http://www.adventures-n-fun.com/castleprimary.jpg>

Inflatable slides are inflatable structures that contain an inclined surface that one can use to travel in a downward direction. Rental slides can range of sizes, from under 13’ to slides over 25’ tall. While not as common in the home rental business as bounce houses, they are becoming popular attractions at fairs, carnivals, and promotional events.

Figure 2: Inflatable Slide



Source: <http://www.apartywithus.com/images/Super-Slide-drop-shadow.jpg>

Interactive inflatable attractions include such games as sumo wrestling, jousting, and boxing held inside an inflatable ring or on top of an inflatable base. Also included are amusements like bungee run, a game where two people see who can run the farthest before a bungee cord attached to their harness snaps them back.

Figure 4: Bungee Run



Source: http://www.totalrebound.com/images/gamepix/Human_Slingshot.jpeg

Figure 5: Inflatable Boxing Attraction



Source:

<http://images.google.com/imgres?imgurl=http://www.aopartyrentals.com/images/Corporate%2520Events/corporate%2520event%2520inflatable%2520boxing%25201.jpg&imgrefurl=http://www.aopartyrentals.com/corporateevents.shtml&h=1215&w=1800&sz=906&tbnid=2CKxdCGL18oJ:&tbnh=101&tbnw=150&hl=en&start=1&prev=/images%3Fq%3Dboxing%2Binflatable%26svnum%3D10%26hl%3Den%26lr%3D%26safe%3Doff%26sa%3DG>

Figure 6: Inflatable Jousting Attraction



Source:

http://www.vanderbilt.edu/studentlife/photos/greekweek05/images/greek05_07.jpg

Inflatable obstacle courses are inflatable structures containing elements or

challenges that participants must overcome. Examples include small walls to climb, small pillars to push through, or slides to go down. It is common for two or more participants to race each other through an obstacle course, often in different lanes.

Figure 7: Inflatable Obstacle Course



Source: http://muslimfest.net/images/inflatable_rental_obstacle_course_lrg.jpg

Inflatable climbing walls are inflatable wall structures that one can climb up using foot and hand holds. There are many variations of these climbing walls from a vertical wall to a miniature version of a mountain. Belay systems and harnesses are often incorporated into the device for safety reasons.

Figure 8: Inflatable Climbing Wall

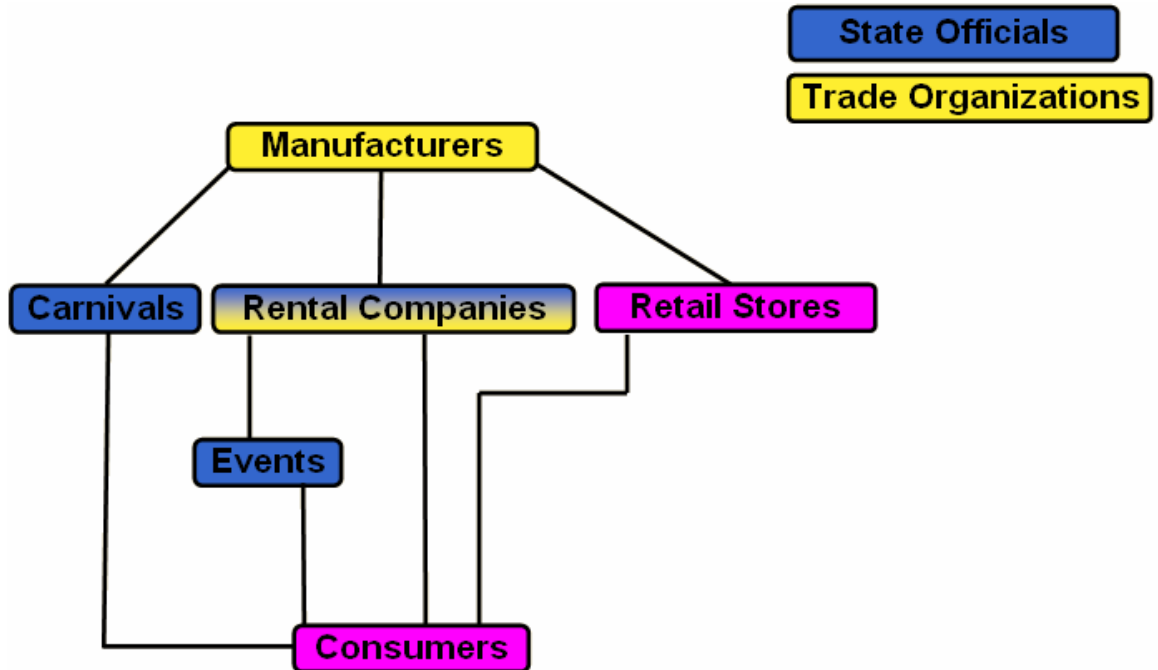


Source: <http://newyorkskylineent.com/Inflatable%20Rock%20Wall.jpg>

2.2 The Inflatable Amusement Industry

The inflatable amusement industry is composed of several different groups: manufacturers, carnivals, rental companies, retail stores, events, consumers, state officials, and trade organizations. Manufacturers produce the rides and sell them to the rental companies and retail stores. Retail stores sell smaller, less expensive ones directly to consumers. The rental companies rent out the larger, more expensive inflatable amusement rides, either for large events or directly to consumers for backyard parties. State officials are the employees of various states in charge of setting standards for inflatables and inspecting them. Trade organizations are industry-created groups that help educate and self-police the manufacturers and rental companies.

Figure 9: Inflatable Industry



“The inflatable amusement business has grown significantly, according to Scott Borowsky, president of the International Inflatable Products and Games Association in Ardmore, PA. Borowsky said at least 1,800 companies rent them for children's parties and other events, and an undetermined number of carnivals, fairs and parks also offer them” ([McCutcheon, 1](#)). In many areas renting inflatable amusements for children's birthday parties has become commonplace, creating a boom in the industry since the mid 1990s. Due to this great increase in the demand there has also been an increase in the number of rental companies. Often a large number of relatively new rental companies compete for business, causing some businesses to focus on keeping prices low rather than improving safety. The number of companies in the business is also due to the low initial investment required for start-up. For less than \$10,000 an owner can purchase three to five rental inflatables with blowers and stakes. Also, a storefront is often unnecessary since customers usually order by phone.

2.3 Recent CPSC Activity

Recently “the U.S. Consumer Product Safety Commission noted a ‘significant upward trend’ in serious injuries involving inflatable rides. “According to the Consumer Product Safety Commission, inflatable rides accounted for an estimated 4,300 injuries requiring hospital emergency room visits in 2003, the most recent year for which statistics are available. In 1997, there were 1,300 injuries” ([McCutcheon](#)).

The CPSC has been studying inflatable amusement attractions since 1987 with the goal of avoiding potential dangers and improving their overall safety ([CPSC Report, 1987-2000](#)), but has not yet had the time to delve fully into the problem.

One set of useful data is the collection of the CPSC’s published reports. We obtained the report discussing injuries from 1987 to 2000 as well as the 2002, 2003, 2004 and 2005 updates. We also acquired a CPSC bulletin from 2001 discussing proper set-up and use. The reports are good sources for the estimated number of injuries. They also outline the methodology that the CPSC has followed in its previous inflatable amusements work.

Another official group we received information from is the CPSC amusement rides team. As our study is a subset of their work, they were an obvious source of information and direction. Unfortunately, due to their staffing and time constraints, they had not thoroughly explored the topic. They were very helpful in providing various journal/newspaper articles as well as answering questions about the industry.

2.4.a Project Goals

At the beginning of this project, the CPSC asked that our project be focused on

meeting three main goals:

- ❖ **Categorize/ define the various inflatables**
- ❖ **Make recommendations on how the CPSC can improve the safety of inflatable amusements**
- ❖ **Suggest future courses of action by CPSC**

2.4.b Fulfilling the IQP requirement/ Qualifying as an IQP

“All WPI students complete a unique science, technology and society project (the Interactive Qualifying Project, or IQP), through which students address significant social problems and issues for agencies and organizations. To complete this project, students must often acquire knowledge in fields well removed from their major field of study. The IQP has been widely recognized as the most creative and effective innovation in technological education in the last quarter century.” ([WPI's Unique Approach to Global Studies](#))

In working with the U.S. Consumer Product Safety Commission, we have explored an area outside of our respective fields of study. Instead of engineering, we delved into how a booming industry works and the how federal recommendations and state legislation have and will affect it. We saw how regulations and requirements enacted at different levels affect the overall safety of a consumer product. Our ideal recommendations were tempered by the economic realities of industry filled with small businesses and regulating community constrained by state budgets. We studied where society, business, and engineering meet and searched for the best solutions for those involved.

3. Injury Data

This section details the number and nature of injuries and fatalities occurring on inflatable amusement rides. All numbers are estimated using the NEISS database and refer only to injuries occurring within the United States. International fatalities discovered during our research are briefly discussed.

Tables of injury data previously released by the CPSC can be found in [Appendices C](#) through [E](#).

3.1 Fatalities

In May of 2001 the CPSC issued a safety bulletin, in response to injuries that occurred in 2001, including three deaths that the CPSC was aware of (CPSC Safety Bulletin). Two of these were suffocations. The victims were ages two ([IDI 890922CAA2423](#)) and five ([IDI 920625CWE6001](#)). Since 2002, the CPSC has documented 4 deaths involving different inflatable attractions in the United States, as shown in [Table 1](#).

Table 1: Reported Fatalities for Inflatable Attractions from 2002 to 2005

Reported Non-Occupational Inflatable Amusement Ride Fatalities.

Document Number	Year	State	Narrative
N0260191A	2002	FL	A 21-year-old male broke his neck and died while jumping in an inflatable bounce.
G0350014A	2003	IL	A 15-year-old male fell head first off an inflatable obstacle course slide and died of traumatic head injury four days after the incident.
X0520106A	2004	MN	An 18-year-old male died after he fell on his head from an inflatable slide.
X0551104A	2005	MA	A 24-year-old female died after falling from a 28-foot inflatable climbing wall and striking her head on the pavement.

Source: CPSC Report, 2005 Pg.9

Other sources have documented deaths outside of the United States. An 8-year-old girl in Australia was killed when an inflatable was lifted ten feet into the air by a freak gust of wind. In Canada a 19-year-old male died from head injuries after falling from an inflatable climbing wall. (RideAccidents.com)

Interestingly, in almost all recently reported fatalities, the victims were between the ages of 15 and 24, whereas [most nonfatal injuries occur in ages 3-11](#). Also worth noting is that these teenagers and young adults who died all suffered head and/or neck injuries, usually caused by a fall.

3.2 Injury Data Obtained From Databases

To determine the severity of the inflatable amusement ride injury problem, we had to determine the number of, as well as type of injuries. Injury databases, a type of “official documentary records,” ([Berg](#), 214) seemed an appropriate resource as they are objective sources of such information. These databases are routinely used by CPSC

employees during their investigations into products. Therefore we decided to emulate their approach.

For this project, four CPSC databases were accessed: the National Electronic Injury Surveillance System (NEISS), a death certificate database (DTHS), In-Depth Investigation File (INDP), and Injury or Potential Injury Incident File (IPII).

The NEISS database contains reports from selected emergency rooms across the country. These emergency rooms are weighted statistically, so that using the number of incidents and the appropriate weights, one can estimate the number of injuries nationwide. The DTHS database contains death certificates that the CPSC has purchased from states based on product codes. The INDP database contains the in-depth investigations conducted of select incidents that CPSC officials have done. These reports contain any relevant data the field investigator was able to collect (police reports, witness statements, operating instructions, etc). The IPII database contains information collected from newspapers, magazines, and any other second-hand reports the CPSC has received that could indicate a potentially harmful product.

3.3 Search Criteria Used for Database Analysis

While searching the four different databases we had access to, The National Electronic Injury Surveillance System (NEISS), In-depth Investigations (INDP), death certificates (DTHS), and Injury or Potential Injury Incidents (IPII), we used very specific search criteria to obtain our results.

- ❖ Incidents occurring between January 1, 1987 and October 25, 2005.

(We decided to use the year 1987 as a starting point because the first publication the CPSC released to the public concerning inflatable attractions covered the years 1987 to 2000 ([CPSC, Report 1987 to 2000](#)).)

- ❖ Involving Product Code product #1293.

(1293 is the code for Amusement Attractions (Including Rides))

Inflatable amusements are a subset of this category.

- ❖ The narrative, if applicable, included at least one of the following: MOON, BOUNCE, INFLATABLE, INFLATE. These words were used as search criteria because these are the words are most commonly used to describe inflatable amusement rides.
- ❖ In some areas we had to review each case individually to determine whether or not it involved inflatable amusement rides.

The results of these searches were then read individually and each relevant entry inserted into a spreadsheet. For the INDP database, some of the narratives were reworded based on the information found in the accompanying pages of the report. This was done for confusing entries, as well as for ones lacking in clear descriptions. The entries were then sorted by date of injury and saved as an Excel database.

The data was separated into the [five different categories](#) of inflatable attraction and then sorted by [age groups](#). This was used to determine which age group has a higher probability of getting injured on each type of inflatable. The [types of injuries](#) sustained were also tallied. Finally, the data was also sorted by [year of incident](#) to view how the injury rate has changed over the years. The resulting estimated numbers of injuries are in the next section. Please note: Weights below 500 are usually not considered precise

enough to be reasonably accurate ([Levenson](#)).

3.4 Results from Database Analysis

The data that compiled from the NEISS database was used mainly to determine quantitative results. The NEISS narratives are often not descriptive enough to determine the cause of the accident, but only the severity of the injury and type of amusement. To compile results from the NEISS database, we sorted the data by our given criteria and then used the CPSC NEISS weighting system to statistically adjust the data to reflect injuries on a national level. In order to see how many injuries occur with each type of inflatable attraction, we separated the information by type of inflatable. This data was useful for determining which type(s) of inflatable are related to a majority of the injuries. The different groups are bounce houses, slides, interactive inflatable attractions, obstacle courses, and climbing walls.

Table 2: Estimated Number of Injuries from 1987 to 2004 in United States

Type	Estimated Number of Injuries*
Bounce House	26730
Slide	562
Interactive, Climbing Walls, and Obstacle Courses	335
	*Rounded to the nearest whole number

Source: NEISS Database

Table 2 shows that the majority of injuries, 96% of all injuries from 1987 to 2004 occurring in United States in relation to inflatable attractions, occurred on Bounce Houses.

To determine which age group suffers the most injuries on inflatable attraction, we sorted the NEISS data by age only. After 12 years old, the estimated number of injuries decreases rapidly, so from 13 to 20 years old we grouped the ages by two years. From 21 years old and onward, the years were combined in groups of five years.

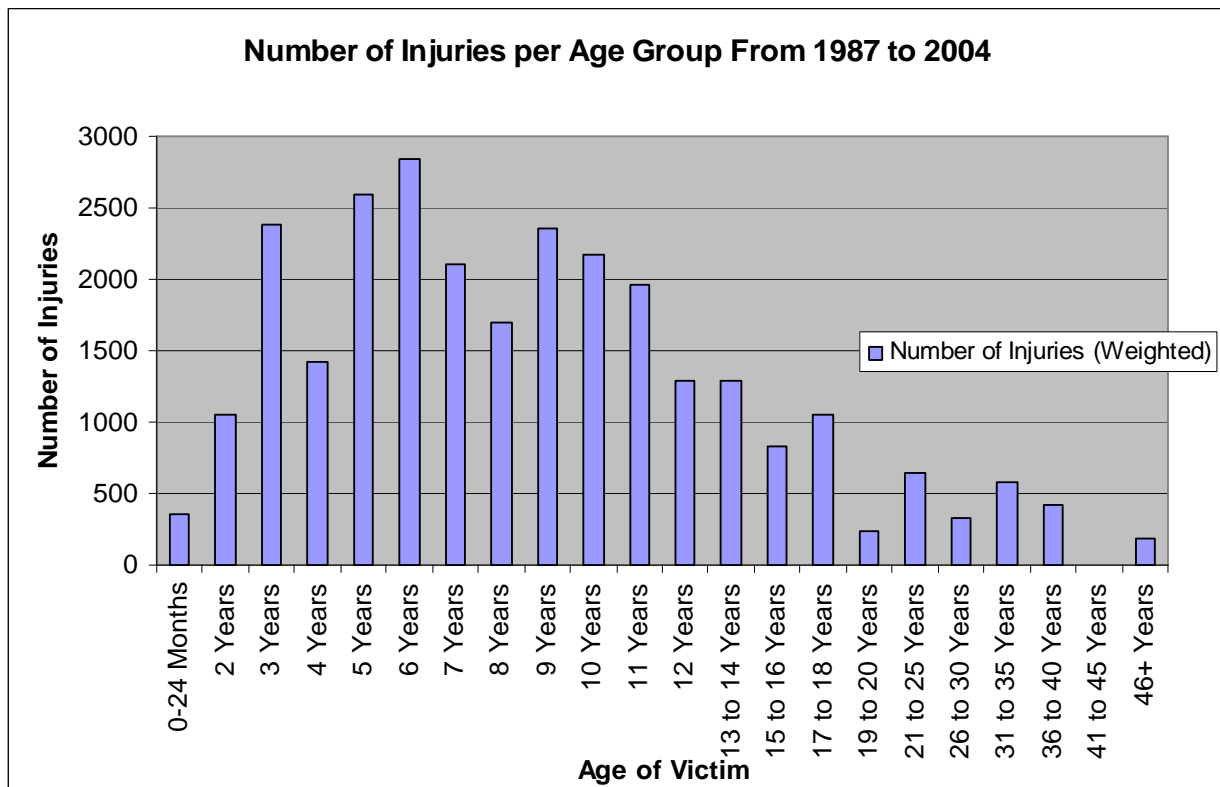
Table 3: Estimated Number of Injuries per Age Group from 1987 to 2004 in United States for all Inflatable Attractions

Age	Estimated Number of Injuries*
0-24 Months	361
2 Years	1049
3 Years	2385
4 Years	1426
5 Years	2597
6 Years	2837
7 Years	2107
8 Years	1693
9 Years	2349
10 Years	2169
11 Years	1957
12 Years	1295
13 to 14 Years	1294
15 to 16 Years	833
17 to 18 Years	1056
19 to 20 Years	236

21 to 25 Years	645
26 to 30 Years	335
31 to 35 Years	584
36 to 40 Years	416
41 to 45 Years	0
46+ Years	181
	*Rounded to the nearest whole number

Source: NEISS Database

Figure 10: Estimated Number of Injuries per Age Group from 1987 to 2004 in United States for Inflatable Attractions



Source: NEISS Database

Table 3 and Figure 10 both show that the largest number of injuries occur between the ages of 3 and 11 years old. Interestingly, three and five-year-olds have each

had almost double the amount of injuries as four-year-olds. Also worth noting are the injuries for those over 20 years old. While much lower than the number of children injured, the number of adults hurt on inflatables indicate that these devices are not being used solely by kids. Therefore, adult occupants need to be taken into account when looking at the safety of inflatables.

The different injuries victims received on these products ranged from contusions to paralysis. The majority of reported injuries were sprains/ strains and fractures; both accounted for more than an estimated 6,000 injuries from 1997 to 2004. Lacerations and internal injuries each had over 1,000 reported and there were about 400 reported instances each for contusions/abrasions and dislocations. These numbers only account for injuries that involved emergency room visits.

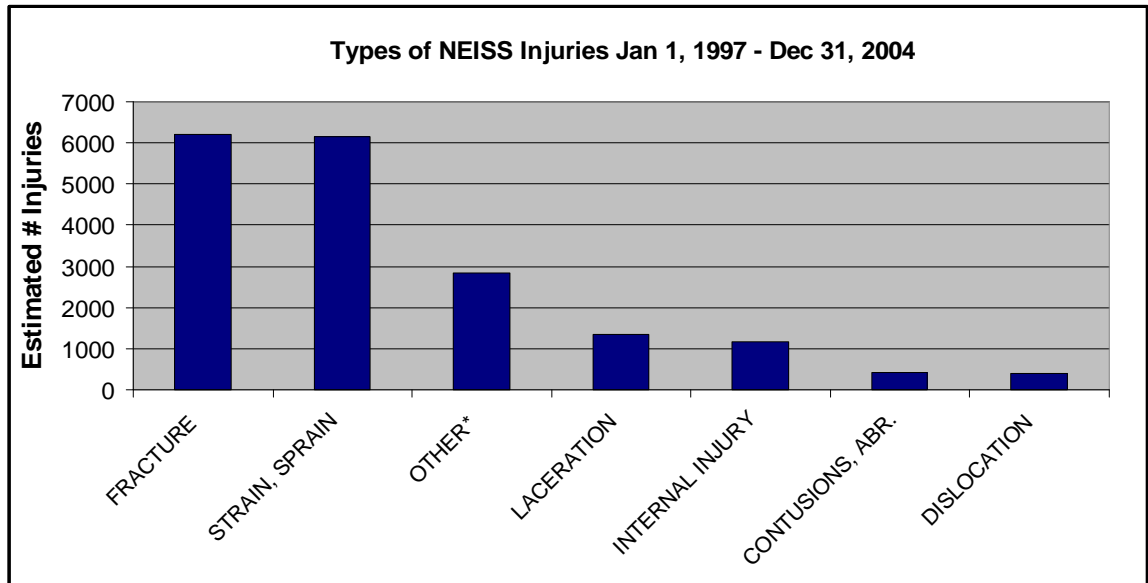
Table 4: Estimated Number of Injuries per Type of Injury from 1997 to 2004

FRACTURE	6212
STRAIN, SPRAIN	6146
OTHER*	2836
LACERATION	1354
INTERNAL INJURY	1168
CONTUSIONS, ABR.	435
DISLOCATION	403

*“Other” includes concussion, crushing, hematoma, dental injury, nerve damage, puncture, dermatitis, and unknown.

Source: NEISS Database

Figure 11: Estimated Number of Injuries per Type of Injury from 1997 to 2004



*“Other” includes concussion, crushing, hematoma, dental injury, nerve damage, puncture, dermatitis, and unknown.

Source: NEISS Database

It was necessary to separate the injuries by each year to look for any possible trends. Table 4 and Figure 12 show that there was an increase in injuries corroborates the CPSC’s hypothesis that injuries occurring on inflatable amusement rides have more than tripled since 1997.

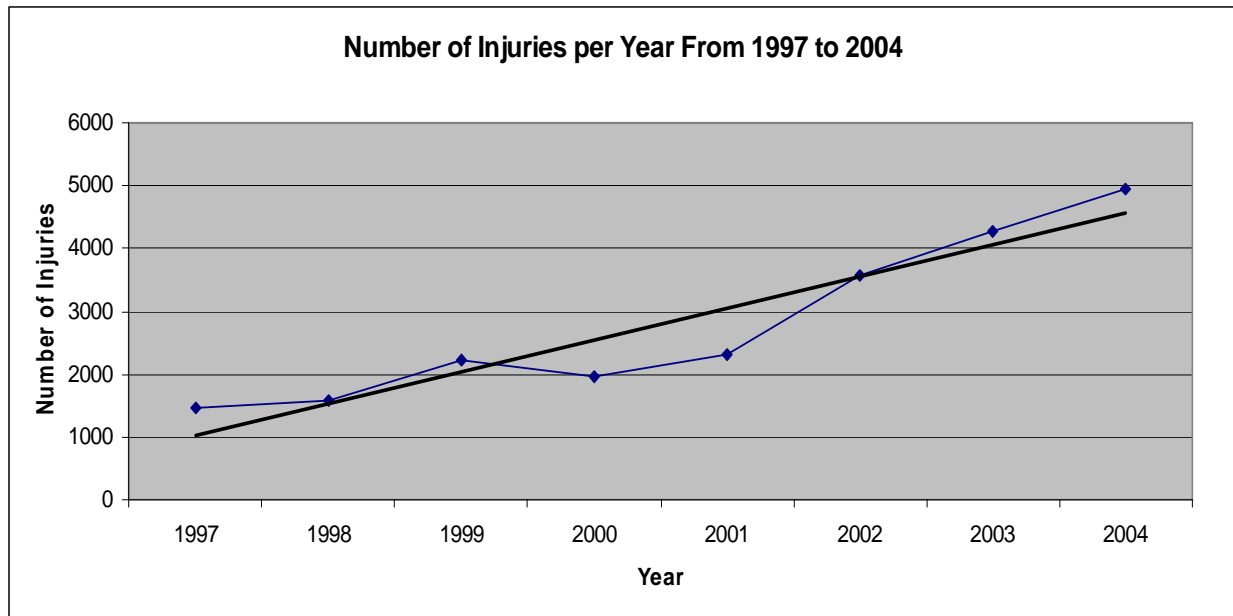
Table 5: Estimated Number of Injuries Each Year from 1987 to 2004 in United States

Year	Number of Injuries*
1987	119
1988	188
1989	345
1990	645
1991	485
1992	444
1993	712

1994	730
1995	691
1996	1242
1997	1455
1998	1569
1999	2232
2000	1959
2001	2310
2002	3570
2003	4283
2004	4956
*Round to the nearest one	

Source: NEISS Database

Figure 12: Estimated Number of Injuries per Year from 1997 to 2004 in United States



Source: NEISS Database

In 1997, the hospitals that report their information to the NEISS database were switched for a new set of hospitals. This creates another variable when comparing

injuries occurring between 1987 and 1996 to injuries occurring after this point. However, we observed that there was little change between 1996 and 1997, and this leads us to believe that this change had little effect on the NEISS estimates.

4. Environmental and Human Causes for Injury

According to the CPSC, there has been a significantly increase in inflatable ride injuries from 1997 to 2003 ([CPSC, Report 2004](#)). There are several possible causes for the increase in injuries. Among these causes are environmental conditions, operator error, equipment failure, overcrowding, rough housing, etc.

4.1 Environmental – Wind and Rain

Wind is often a factor in injuries caused by inflatables. There have been cases of sudden gusts of wind blowing over inflatables. In July of 2005, “at least three children were injured when a gust of wind sent an inflatable castle flying through the air. The children fell 25-35 feet and landed on pavement. One child was hospitalized in intensive care; two others required surgery. The accident happened in Pila, Poland” ([RideAccidents.com](#)).

Another dangerous environmental condition for inflatable rides is rain. The rides can become slippery and people can slide off the inflatable causing injury. The rain can also make ground conditions troublesome by muddying the soil. This can prevent the inflatable from being staked down properly or sufficiently.

4.2a Overcrowding

Overcrowding is an identified hazard for inflatable rides. In June of 2004 “eight children were injured in a 20-foot fall from an inflatable ride after the ride collapsed. The children were taken to hospitals for treatment of their injuries, most of which were minor. A preliminary investigation by the South Brunswick Fire Safety Bureau found that the

operators did not have a license to operate the ride as required by the state Division of Community Affairs; that ride attendants were unaware that the maximum load for the ride was only two children; that the ride was not properly anchored to the ground; that the ride was improperly powered by extension cords; and that the ride was operated by persons with insufficient guidance about safety issues,” ([RideAccidents.com](#)).

Overcrowding can occur for many reasons. As illustrated above, the reason for overcrowding can be as simple as the operators are unaware of the maximum number of occupants. Other times the occupants can cause the overcrowding themselves, either by not listening to the operator or not reading any signs if they are present.

4.2.b Operator Error

“Too many operators regard inflatable rides as ‘big and soft’ and relatively harmless”, said [Mark Zientek](#), chairman of Responsible Operators of Amusement Rentals (ROAR), an industry group formed in December 2003 ([McCutcheon](#)).

In May of 2005, a 24-year-old woman died from injuries she sustained in a fall from an inflatable climbing wall at a festival in Mansfield, Massachusetts on Sunday night. Normally, the ride attendant wears a strap around his waist or cinches it to the platform below to prevent a climber's fall; however the attendant who was working with the victim had apparently failed to attach the strap around his waist, and was not holding it incorrectly. Witnesses say that when the victim told the attendant that she wanted to get down, the attendant responded by saying, “Let go, I gotcha.” The victim fell from three-fourths of the way up and landed half way on the mat. Her legs and lower body hit the inflated base and her head and upper body hit the pavement, resulting in serious head

trauma. She died due to these injuries three days later. ([IDI 050531CNE2459](#))

Throughout our research there has been a recurring theme; that having attentive, properly trained operators is the first step to reducing injuries on inflatable amusements.

4.2.c Other Causes

Equipment failure, though rare, can be very dangerous. Cables that have been improperly repaired or inflatable attractions that have been quickly patched can cause serious injury. Blowers that suddenly stop working can cause the ride to deflate rapidly and often without warning. This can lead to situations that are very unsafe.

The human factor can often come into play. Rough-housing on an inflatable ride can be very dangerous, especially on an inflatable slide or other tall ride. A child could lose their balance and fall, potentially hurting themselves.

Another problem that occurs in the inflatable industry is insufficient communication with, or training of, the operator. In April of 2005, “an inflatable ride was carried away in strong winds with a 5-year-old girl and her 22-month-old sister inside. The girls suffered only minor injuries. The girls' parents rented the ride -- an inflatable castle in which children bounce and play. They say that the release form that they signed warned of the dangers that high winds pose to inflatable rides, but that they never read the paperwork. They say that the rental company, C&J Party Rental, should have warned them verbally,” ([RideAccidents.com](#)).

With rides increasing in popularity, the danger exists that some companies, being so eager to rent out as many rides as possible, will not take the proper time to inspect or maintain the rides or to educate the operators. This is why we recommend having outside

safety features in place such as having mandatory standards that companies must adhere to or having state officials inspecting the rides on a regular basis.

5. Surveys

In order to understand current regulations, we surveyed the [state officials](#) in charge of amusements. With such a small population to survey, we chose the entire population. A survey was sent to an official from each state. Contact information was provided by a CPSC employee who worked with the amusement industry. We asked each official questions about how his/her state handled inflatable devices as well as what types of injuries they had been seeing. There was also a question about which injuries would be easiest to prevent to help us determine the most effective solutions.

[Manufacturers](#) are in charge of designing, and fabricating these amusements, and therefore an obvious source of information. We emailed our surveys to several American manufacturers we found online as well as foreign and American manufacturers listed in trade magazines. A conscious effort was made to survey manufacturers from other countries as manufacturing practices are likely to vary from nation to nation.

[Trade Associations](#) whether representing manufacturers, rental companies, or both can tell us what their members and the industry in general are doing. Because of this wealth of information as well as there being a limited number of these associations in existence, we sent surveys to the eight major associations we came across in our research.

[Rental companies](#) were surveyed as well. As regulations and enforcement vary greatly from state to state, it was important to try to get responses from as many states as possible. Therefore, we used a stratified sampling approach, making sure that our selected renters represented almost every state. Renters were asked general questions about how they operated with safety questions spread throughout the survey. The intent was to make the survey disarming enough to increase response while still asking enough

safety questions to collect useful data.

Response:

Despite sending approximately 200 surveys, less than a dozen answered surveys were received. None of the trade organizations or manufacturers surveys were returned. All of the state official responses were from states that did not regulate inflatable amusements. (Therefore most of the questions were irrelevant.) The rental company responses we received were far too few to draw conclusions about such a widespread industry. Overall the surveys provided little, if any, useful data, on the questions posed. However this is a clear demonstration of the difficulties associated with getting feedback from this industry.

6. INTERVIEWS

To thoroughly explore the inflatable amusement issue, inflatable amusement experts were interviewed. [Fackler](#)'s interview were conducted via email. This interview were done to gather facts; they were not part of a sample. Therefore, each interviewee was asked a unique set of questions. The interviewees were contacted by one group member, who served as the contact for all communication with the interviewee. Questions were formulated by the team and then sent from the contact's email address.

The remainder of the interviews was done via telephone using a semi-standardized interviewing style. This style was selected because we had some specific questions we wanted to ask, but also wanted to let these officials talk about what concerned them. We probed when appropriate and added personalized questions for some interviews. These interviews were done using speakerphone, allowing all three members to ask questions. One person operated a laptop, which had relevant data on it while the other team members took notes. The statements made by the interviewee's are solely the opinions of the interviewee and do not reflect the organization they work for.

6.1 Trade Organizations:

Jim Barber from NAARSO

Jim Barber from National Association of Amusement Ride Safety Officials was picked to be interviewed because this association made up of "amusement ride inspectors representing jurisdictional agencies, insurance companies, private consultants, safety professionals, and federal government agencies," ([NAARSO homepage](#)). Barber explained that NAARSO does not pass legislation and trains people on proper amusement

setup and use. NAARSO considers inflatable amusement a subset of amusement rides and does not have usage numbers.

Barber feels that the industry does have its problems, including rental companies that do not show customers how to use the inflatable amusements properly. According to Barber, both wind and mixing of age groups, such as 16 year olds with three year olds, inside bounce houses has contributed to the amount of injuries that have occurred. Barber mentioned an incident in Oklahoma City in which an inflatable amusement was blown across a four-lane highway with the children still inside.

According to Barber, all inflatable attractions should have an operator to supervise the participants. Barber thinks it is likely to see legislation passed requiring operators. Currently, state regulations concerning inflatable devices vary greatly from state to state. Many states have yet to adopt ASTM standards. Money is a main factor when deciding how strict state legislation and enforcing are.

Customers think of inflatable devices as soft and bouncy and that they could not get hurt on them. Barber believes that accidents will continue to happen until something like OSHA for amusement rides comes into existence. However he believes that it is unlikely for this to occur.

The inflatable industry is growing everyday and will do so until the market is saturated. It is in the best interest of the industry to regulate inflatable devices. So far at least a portion of the industry composed of responsible people are trying to do the right thing by trying to get everyone to comply with a code of ethics, according to Barber. The industry is currently having a hard time with insurance. In Barber's opinion, if the industry followed a code of ethics, then insurance premiums would be lower.

When Barber went to the IAAPA convention in Atlanta, one of the manufacturers he met was not even aware of ASTM standards. Inflatable devices are made overseas in places such as China, Hong Kong, and the Philippines.

If a rental company becomes incorporated it is protected from operating irresponsibly. If someone, who became injured on the device, tries to sue a company without insurance, all they can receive is the company assets, which is likely to just be the inflatable devices themselves. Rental companies sometimes change names every few years, which may protect them from bad reputations.

Mark Zientek, a Chairman of ROAR

Mark Zientek, the chairman of Responsible Operators of Amusement Rentals, was interviewed because ROAR is a safety conscious trade organization. ROAR was started because of concerned operators and disturbing news in the media concerning inflatable devices. ROAR's mission is "to develop a 'culture of safety' among owners and operators of amusement rental structures including the development of a code of ethics, the adoption of safety guidelines with respect to regulatory agencies and attraction manufacturers/suppliers, and the implementation of an operator training and certification program," ([ROAR homepage](#)).

Zientek hopes that more public awareness about ROAR's practices will bring more business to its members. Currently, ROAR has about 100 members owning thousands of inflatable devices. Anyone is allowed to join the organization, including people who are interested in the industry.

Members of ROAR do not just join and pay dues; they also have to follow certain

rules. These rules include strict risk management, employee education, going to training programs taught by NAARSO, and having a 1 to 2 million dollar minimum insurance. Members also give itineraries for the inflatable devices and inspectors will randomly show up to check the setup and enforce policies. In some cases, members save money on insurance premiums because they follow policies geared towards safety. ROAR members have 40-50% less injuries than nonmembers according to actuaries.

Zientek believes that the rise in injuries is related to injuries in connection with [consumer purchased inflatable attractions](#) being lumped in with injuries due to rented inflatable devices. Zientek says he does not have good statistics for usage numbers and feels great about the industry. He sees the inflatable rental companies replacing local carnivals.

Kathy Fackler from Saferparks.org

Kathy Fackler, who is in charge of [Saferparks.org](#), was interviewed because Saferparks is a consumer advocate group. Fackler stated that Saferparks attention is not focused on inflatable attractions because she believes that the CPSC has done “investigative work on identifying hazard patterns,” and they have issued a safety bulletin describing preventive measures.

6.2 State Officials:

Source Familiar with New Jersey Regulations

A source familiar with New Jersey regulations was picked to be interviewed because multiple sources mentioned that New Jersey has the strictest inflatable

regulations. This source mentioned that New Jersey became interested in regulating inflatable attractions after discovering some attractions that formerly followed ASTM standard 701 for self-extinguishing, were failing to meet the requirement. These inflatables were not self-extinguishing in the two seconds required by the standard.

In 2000, it was reported that New Jersey inspected 100 inflatable attractions; however, in 2005 state officials inspected 600 inflatable attractions. According to the source, the total numbers of injuries have decreased in New Jersey since the state passed stringent legislation even though the usage numbers have increased. The source stated that the most injuries occur on inflatable slides, which could almost be entirely eliminated if manufacturer standards were followed by rental companies.

According to the source, New Jersey tries to convince operators to get training. New Jersey inspectors enforce the legislation by watching the operators at events. Penalties can be levied on the rental companies and can run up to \$5,000. Most penalties are for setting up at a location without informing the state, which is required by regulations. Rental Companies that comply with state regulations cannot compete with illegal companies due to the cost of safety requirements. State inspectors try to find illegal rental companies by reading the ads that the companies put out to attract business. The industry's response to state regulations was to create a trade organization called [ROAR](#) to help self-police the industry.

The source has noticed the following new safety features that the manufactures are releasing in the new inflatable attraction: deeper stakes; internal baffling, which allows evenly distributed deflating; and swing check valve. According to New Jersey regulation, inflatable attractions must remain inflated for one minute after the blower is

disconnected. The internal baffling and swing check valve help rental companies comply with this regulation.

Mark Doman, a State Official from Michigan

Mark Doman, a state official from Michigan, was picked to be interviewed because Michigan does not regulate or have a minimum insurance for rental companies. In order to get a well-rounded understanding of state regulations, we wanted to talk to states that regulate and also the ones that do not regulate. When we sent a survey to Mark Doman, he replied back saying that he is interested in our work since Michigan is currently looking into starting to regulate inflatable attractions. Michigan is considering this due to national interest in inflatable attractions and there is pressure from the industry to regulate. Doman believes that usage numbers have increased at about the same rate as injury numbers.

Presently, Michigan has a poor economy and it must balance regulations with financial restrictions. Michigan does not currently have inspectors to apply to dealing with inflatable attractions. According to Doman, Michigan is continuing its research into the industry and wants to see how other states are tackling the concern with inflatable attractions. Michigan is interested in how Pennsylvania requires a state-certified third party inspector. These third party inspectors set their own prices, which is paid by the rental companies. Michigan is using student interns to assess the number of inflatable attractions in the state; the current estimate is 7000 units.

Mark Mooney, a State Official from Massachusetts

Mark Mooney, a state official from Massachusetts, was interviewed because the most recent fatality occurred in that state and Massachusetts has thorough regulations for inflatable attractions. According to Mooney, Massachusetts is taking a “drastically different approach” to inflatable attractions. New regulations, which were discussed in 2002, were put into place in September of 2005. Now the state inspects 100% of the inflatable devices in the state instead of the previous 10%. With the new regulations, all injuries requiring professional medical attention must be reported; previously injuries did not have to be reported to the state.

Massachusetts has 25 inspectors; however amusement rides are only a subset of their job description. Inspectors are trained one week at the beginning of and throughout the year by NAARSO. The biggest challenge for the inspectors is to hunt down “fly-by-night” rental companies. Inspectors rely on self-policing, where companies following the laws tend to report the illegal companies.

All inflatable devices are inspected annually. Large inflatable, which are considered 12’ or higher, are inspected at every setup; however, devices that are smaller than 12’ are not inspected at every setup. A failed inspection results in the device not being allowed to be used legally. Violations of regulations can be punished by a fine up to \$1,000, a year in prison, or both.

When inspectors check inflatable attractions, they look for safety features, GFCI, tears and rips. Inspectors also look for other things when inspecting a setup, such as the following: ensuring there are no interferences such as power lines, buildings; that the device is properly staked down and anchored; and there are no tripping hazards. Rental companies are required to keep a log documenting training of its operators.

According to Mooney, customers contribute to 50% of the accidents. This however was not the case concerning the Mansfield fatality, where it was “clearly a case of untrained operators” and “company negligence.” According to Mooney, there was no manual for the device, license or itinerary for the device, and was being operated by an untrained operator.

6.3 Miscellaneous Interviews:

Charles Ackerman, Quality Assurance Manager, FCI USA INC.

Chuck Ackerman was interviewed via telephone for the purposes of gaining information on various standards. ISO, ASTM, UL, and other standards were discussed. This gave us several points to focus our standards research on.

David Shibiliala, Head Design Engineer, FCI USA INC.

Dave Shibiliala was interviewed via telephone and email for the purpose of gaining information on UL listing. Shibiliala is well versed in UL matters and was also able to put us in contact with someone with even more UL knowledge. This was extremely helpful in determining the UL507 matters and recommendations.

7. Online Forum: AIRCO Moonwalk Rental Forum

Reading Forums

Posts found on an [online forum](#) designed for rental companies were read in order to gain more knowledge about the industry. Polls about business practices, safety, insurance, legislation, etc. were analyzed. Conversations and debates about these topics were also available. These posts and polls were used to explore trends and attitudes of those in the industry.

While looking online for information on inflatable amusements, our group discovered a forum called Association of Inflatable Rental Company Operators, Airco. This forum's members include rental companies and manufacturers from around the world who come together to talk about inflatable amusements. We posted our rental company survey on this site, www.a-irco.org, to compensate for the lack of feedback from emailing the surveys to rental companies. These posts were under the username "ChristopherMoonWalken".

The survey (<http://www.a-irco.org/forum/index.php?showtopic=4306>) was posted in the forum section called "Inflatable Rental Biz Questions" on November 16, 2005. However, as of December 7, 2005, our post was viewed 279 times with zero responses to the survey. At the suggestion of a forum member on November 29, 2005, we changed our strategy and began posting polls on the forum. Polls are more convenient for the members to answer than a survey as they select a multiple choice answer and only answer the questions they want to. We posted three polls called "What Type of Inflatable Rents the Best," "What Type of Inflatable Do You Rent," and "Who Sets Up the Inflatable Attraction." However the responses to these polls were far too limited in order for us to









draw conclusions from.

While looking through the forum we also found polls that would give us insight into different trends among the members of the AIRCO forum. These polls can be started by any forum member to gather information on certain issues they are interested in. The polls we found and the two polls we created fall into the following four different categories: What [Rental Companies can Offer a Consumer](#); [Setup and Supervision](#); [Financial Matters](#); and [Insurance](#). These forums were last viewed on December 8, 2005.

7.1 What Rental Companies Can Offer a Consumer

"The market is saturated beyond belief because of the number of new businesses starting up in the past 2 years," ([Claiborne](#)) sparking competition over consumers. They sometimes try to attract more business by offering their clients different types of amusements that other companies may not have, attractions that may be more thrilling than a common bounce house. The amount of inflatable attractions that the companies have to offer is based on many different factors including how long the company has been in business and available resources.

Figure 13: How Many Units do you have in Your Rental Fleet?


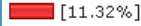


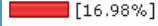
HOW MANY UNITS DO YOU HAVE IN YOUR RENTAL FLEET?		
1-3	[8]	 [17.39%]
4-6	[11]	 [23.91%]
7-9	[5]	 [10.87%]
9-12	[7]	 [15.22%]
13-15	[5]	 [10.87%]
16-20	[5]	 [10.87%]
21-25	[0]	 [0.00%]
25 OR MORE	[5]	 [10.87%]
Total Votes: 46		

Source: <http://www.a-irco.org/forum/index.php?&act=ST&f=4&t=4359&mode=show&st=>

This poll was started on November 27, 2005 and asked the rental companies that were members of the forum how many units they have in their rental fleet. In Figure 13, 23.9% of the 46 rental companies that responded stated they have four to six inflatable attractions in their rental fleet. One member of the forum who goes by www.BigGrins.net stated that he has only been in operation for one year, yet he will have six inflatable attractions by next year. On the more experienced side, one member, called Ken, has 28 inflatable attractions which have “all accumulated over 6 years.” ([How Many Units in Your Rental Fleet](#))

Sometimes a rental company needs to decide whether to invest in a different type of inflatable attraction. One of those new types of inflatable attraction is a combo, a bounce house shell that commonly has either has an obstacle course or just a slide inside. For a rental company, the decision whether to invest more in combos or to keep on buying the common bounce houses can be a hard decision.

Figure 14: Are Bounce Houses Becoming a Thing of the Past?






Are bouncers going away?		
Bouncers are fading because the idea is old.	[0]	 [0.00%]
Bouncers are fading due to the success of combos.	[6]	 [11.32%]
Bouncers are still a good bet at this time.	[10]	 [18.87%]
Bouncers will always be a good bet.	[28]	 [52.83%]
Greg has been inhaling the vinyl fumes to long.	[9]	 [16.98%]
Total Votes: 53		

Source: <http://www.a-irco.org/forum/index.php?&act=ST&f=4&t=2611&mode=show&st=>

In a poll started in February 2, 2005, members were asked for their opinion on the future of bounce houses in the rental industry. As shown in Figure 14, 52.8% out of 53 votes believe that there will continue to be a market for bounce houses. Only 11.3% of the responders believe that bounce houses are losing popularity due to the success of combos. Most bounce houses are used for three to seven year olds and as seen in Figure 21, 35% of the companies that responded make the most money at parties for five to eight year olds. As this important age group favors bounce houses, there is likely to continue to be a demand for these amusement in the coming years, even if the new novelty inflatable is the combo.

Whenever a company needs to decide whether to buy a new inflatable attraction, they sometimes take safety into consideration along with how it will affect their insurance premiums. One type of interactive attraction, inflatable boxing, consists of two opponents hitting each other an inflatable structure while using oversized, heavy boxing gloves. In a poll started on December 20, 2004, companies were polled on whether they owned or planned on buying an inflatable boxing attraction.

Figure 15: Do you own an Inflatable Boxing Attraction?

Do you own one?		
Yes, it does great. No regrets.	[3]	 [15.00%]
Yes, regret it, kinda	[1]	 [5.00%]
No, but planning on it	[2]	 [10.00%]
No, insurance too high	[5]	 [25.00%]
No, won't touch it with a ten foot pole. too dangerous	[9]	 [45.00%]
Total Votes: 20		





Source: <http://www.a-irco.org/forum/index.php?&act=ST&f=4&t=2358&mode=show&st=>

As seen in Figure 15, 45% of the 20 members that responded will not buy an inflatable boxing attraction due to safety concerns. Some argue that the gloves are firm and heavy that a lot of force can be exerted on the person being hit thus people can still get hurt. However on the other hand, 25% of responders either have and do not regret getting it or plan on getting this attraction. Jaxgus, one member of Airco, wrote “I do have a new one now and love it. With the gloves being heavy and big it makes it hard to get any real “solid” punches. The ring makes it fairly safe and it is a good item.”

([Bouncey-Boxing, More opinions needed](#)) Different companies will have varying views on certain inflatable attractions, which in turn gives variety to the customers.

Some rental companies offer different combinations of things to the customers, the most common things are moonwalks, concessions, slides, and interactive attractions. Concessions are used to supplement the inflatable attractions that rental companies can offer to customers. Slides and interactive inflatable attractions are more commonly used at parties other than the backyard parties. In a poll started on January 11, 2004, members of the Airco forum were asked what they offer to the customers.

Figure 16: What do you Offer to Customers?




How many offer slides and interactives?		
Moonwalks Only	[9]	 [26.47%]
Moonwalks and concessions	[4]	 [11.76%]
Moonwalks, Concessions and Slides	[6]	 [17.65%]
Moonwalks, Concessions, Slides, and Interactives	[15]	 [44.12%]
Total Votes: 34		

Source: <http://www.a-irco.org/forum/index.php?&act=ST&f=4&t=17&mode=show&st=>

As shown in Figure 16, 44.1% of the 34 those who answered offer moonwalks, concessions, slides, and interactive attractions to their clients. Some rental companies actually have indoor fun centers that can be rented out to groups or individuals can come to for their kids to play on. Indoor fun centers are places where inflatable attractions are setup inside. One member called catintx stated she had four moonwalks and one slide as of January 15, 2004. She was also working on getting concessions and interactive attractions in her fun center. ([How Many Offer Slides and Interactive](#))

When companies finally decide what type of inflatable attraction they wish to add to their inventory, they have to choose which manufacturer to buy from. Some manufacturing companies operate from America; however, they have the inflatable attraction produced in another country, such as China. In a poll posted on October 5, 2004, rental companies were asked if they would consider buying inflatable attractions that were imported.

Figure 17: Would you buy Imported Units?

Would buy imported units?		
No, strictly american made for me.	[13]	 [26.00%]
Yes, no problem saving a buck here.	[7]	 [14.00%]
Maybe, as long as features, material and quality were the same.	[30]	 [60.00%]
Total Votes: 50		





Source: <http://www.a-irco.org/forum/index.php?&act=ST&f=4&t=1867&mode=show&st=>

According to Figure 17, 60% of the 50 members that responded would buy imported inflatable attractions as long as the features, material and quality were the same as the American counterparts. One member called PartyWright, LLC brought up that most vinyl, which is the main material that they make inflatable attractions out of, is made in China and Mexico. He also mentioned that his two units were made in China but he bought them from an American company. Jumping Jamboree stated his “most popular units are made in China they go out every weekend and have held up so far with no problem.” ([Who Would Buy Imported Units](#))

7.2 Setup and Supervision

There are many surfaces that a rental company can set up a moonwalk on, such as grass, concrete and asphalt, and indoor surfaces. It is common for inflatable attractions to be setup on grass at backyard parties. One member called slyce32818 stated that he gets about two requests for concrete or driveway setups for every 30 requests for grass setups. (Surface For Set-ups, Which surface is most common). In a poll started on July 2, 2004, members were asked what surface they most commonly setup their moonwalks on.

Figure 18: What Surface do you Most Commonly Setup Your Moonwalks on?

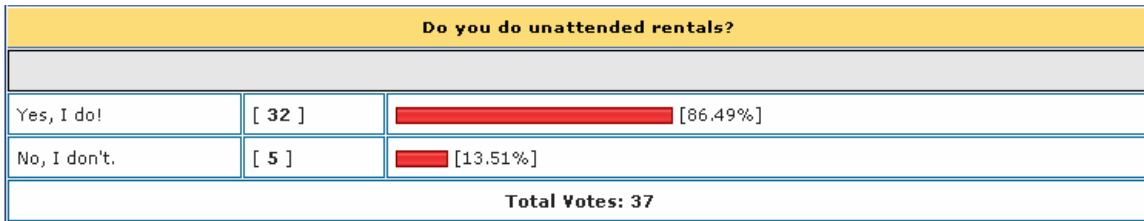
What surface do you most commonly set up your moonwalks on?		
Mostly grass	[43]	 [89.58%]
Mostly concrete/asphalt	[0]	 [0.00%]
Mostly indoors	[0]	 [0.00%]
Equal number of grass and concrete/asphalt	[5]	 [10.42%]
Total Votes: 48		

Source: <http://www.a-irco.org/forum/index.php?&act=ST&f=4&t=1241&mode=show&st=>

According to Figure 18, 89.6% of the 48 respondents setup their moonwalks mostly on grass. Some insurance companies do not allow setups on non-earth or grass, except in certain cases where companies can convince them to use padding on concrete and asphalt setups. A member called thfixitman showed his insurance company, who would only allow setup only on “earth or other approved play surface,” that even this surface was “not necessarily considered a safe play surface” by the CPSC ([Surface for Set-ups, Which surface is most common](#)).

At least one state, New Jersey, requires every rental to be staffed. For some companies, it would be not be economically feasible to only provide attended rentals due to the added expense of operators. (Unattended Rentals, Do You Do Them?) Some rental companies provide unattended rentals to their customers, usually for backyard parties. In a poll started on June 27, 2005, members were asked whether provide the option of unattended rentals to their customers.

Figure 19: Do you provide Unattended Rentals to Your Customers?





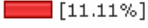
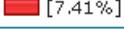


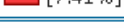



Source: <http://www.a-irco.org/forum/index.php?&act=ST&f=5&t=3777&mode=show&st=>

In Figure 19, 88.6% of the 37 responders will provide unattended rentals to their customers. One member called PartyWright, LLC stated that he only does attended rentals and has a 20' slide and a bounce house. "While most don't do attended rentals, I think if you're going with a big slide and if you're targeting business and large events, you need to do attended rentals. If you're simple doing backyard parties and stuff, unattended rentals are fine." ([Unattended Rentals, Do You Do Them?](#))

7.3 Financial Matters

Different months are busier for rental companies. This can either be due to trends in the number of parties or weather conditions. Determining the busiest month of the year is part of understanding the inflatable industry. In the following poll posted on October 23, 2005, rental companies were asked which month they made the most money renting moonwalks.

Figure 20: What Month do you Make the Most Money Renting Moonwalks?

What month do you make the most money renting moonwalks?		
March	[0]	 [0.00%]
April	[0]	 [0.00%]
May	[3]	 [11.11%]
June	[2]	 [7.41%]
July	[2]	 [7.41%]
August	[1]	 [3.70%]
September	[2]	 [7.41%]
October	[17]	 [62.96%]
November	[0]	 [0.00%]
December	[0]	 [0.00%]
Total Votes: 27		

Source: <http://www.a-irco.org/forum/index.php?&act=ST&f=5&t=4196&mode=show&st=>

In Figure 20, 63% of the 27 responders stated that October is the busiest month for them. Event master reasoned that October is the best because his rentals get rented out for the pumpkin patches. ([Best Month of The Year For Business? Most inflatable Rentals](#)) Ken wrote that May and October are the best months for him because there are a high number of events at schools and churches.

There are many types of events that people would rent inflatable attraction for entertainment purposes. These events can range from backyard parties to teen events, from school and church events to corporate events. One event called pay for play event which is a gathering of some type and the rental company can setup their inflatable attractions and sell tickets for the customers to play on them. In a poll posted on October 23, 2005, members were asked what type of event they make the most money in.

Figure 21: What Type of Events do you make the Most Money In?

What is your highest earnings area?		
Backyard parties- Ages 1-4	[0]	[0.00%]
Backyard parties- Ages 5-8	[7]	[35.00%]
Backyard parties- Ages 9-12	[0]	[0.00%]
Teen Events including church and school events or colleges	[2]	[10.00%]
Elementary School Events	[4]	[20.00%]
Church Events	[3]	[15.00%]
Corporate Events	[1]	[5.00%]
Pay for Play Events	[3]	[15.00%]
Indoor Center	[0]	[0.00%]
Business Rentals (regular gigs for malls, indoor centers, grand openings, etc)	[0]	[0.00%]
Total Votes: 20		







Source: <http://www.a-irco.org/forum/index.php?&act=ST&f=5&t=4197&mode=show&st=>

In Figure 21, 35% of the 20 participants make the most money in backyard parties for ages from five to eight. That combined with the elementary school events which accounted 20% of the respondents’ most profitable rentals is consistent with the high number of injuries for children ages five to eight.

7.4 Insurance

Insurance is an issue for companies because some insurance companies refuse to cover them due to possible risks. 25 states require minimum insurance which can vary from \$200,000 for Maryland to \$2,000,000 for Massachusetts. (MoonwalkForum.com) The median amount of minimum insurance is \$1,000,000.

Figure 22: Is Insurance really a Problem?










Is Insurance really a problem?		
Insurance has been no problem	[12]	 [15.38%]
I still get insurance, it just keeps increasing each year	[24]	 [30.77%]
I can't find insurance coverage	[14]	 [17.95%]
I just don't want to pay the increasing costs	[10]	 [12.82%]
It's just a part of doing business	[7]	 [8.97%]
Insurance is the biggest scam going on in this country	[11]	 [14.10%]
Total Votes: 78		

Source: <http://www.a-irco.org/forum/index.php?&act=ST&f=3&t=2683&mode=show&st=>

Figure 22 shows that 30.8% of 78 votes still get insurance but see the premiums increase each year. One member called tro5lo stated that three years ago in Washington for one bounce the insurance cost \$600 per year. Two years ago the insurance on the same bounce house was \$1,200 and last year the insurance was \$1,999. ([Who is Having Insurance Problems? How Many Really...](#))

One poll we found asked how much the rental company pays for insurance per year. Even though this does not show whether the amount has increased or decreased over the years, this does provide insight into how much of the earnings the company makes goes towards insurance.

Figure 23: How Much Does Your Insurance Cost You Per Year?

How Much Does Your Insurance Cost You Per Year		
Don't Have Insurance	[8]	 [14.55%]
0 - \$1,000	[3]	 [5.45%]
\$1,000 - \$3,000	[12]	 [21.82%]
\$3,000 - \$5,000	[12]	 [21.82%]
\$5,000 - \$7,000	[5]	 [9.09%]
\$7,000 - \$10,000	[9]	 [16.36%]
\$10,000 - \$15,000	[2]	 [3.64%]
\$15,000 - \$20,000	[3]	 [5.45%]
More than \$20,000	[1]	 [1.82%]
Total Votes: 55		

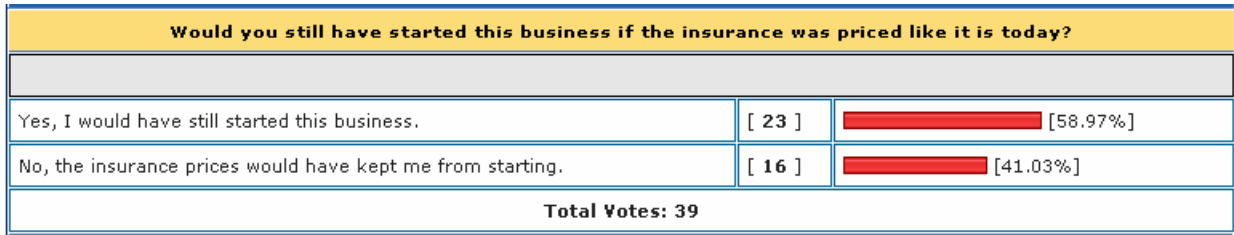
Source: <http://www.a-irco.org/forum/index.php?&act=ST&f=3&t=3992&mode=show&st=>

Figure 23 shows that a majority of companies that responded, 43.6% of the 55 votes, pay between \$1,000 and \$5,000 for their premium for the insurance for the company. One member called YDK stated in post #3 that he pays \$3,400 for two bounce houses and two inflatable slides in Florida. ([What Do You Pay for Insurance Per Year](#)) On the other hand, a member called Event Master stated in post #5 that he has insurance policy that allows him to make up to \$200,000 and does not care how many or which type of inflatable attractions he owns. His premium is between \$15,000 and \$20,000 per year. As shown in Figure 23, 14.6% of the respondents decided to not find insurance. This may have happened for several reasons, such as they either do not know they need insurance, refuse to get insurance due to the high premiums, or they operate in one of the 25 states that do not require minimum insurance. ([MoonwalkForum.com](#))

As demonstrated by the previous polls, insurance is higher than it has been before and in some places is increasing every year. High insurance can be a problem for start up companies if they cannot bring in enough money during the first year to cover start up

cost and insurance. This poll shows whether owners of companies that are already in business would start up if the insurance was as high as it is today.

Figure 24: Would You Still Have Started This Business if the Insurance was Priced Like it is Today?



Source: <http://www.a-irco.org/forum/index.php?&act=ST&f=3&t=2585&mode=show&st=>

In Figure 24, 41%, out of 39 responders, would not start a business if the insurance was priced like it is currently, showing how insurance premiums today would be a deterrent to someone starting up a company. High premiums may also lead to companies going without, therefore removing a safety net for both the company and any injured consumer.

8. Usage Numbers

When determining the safety of a product, the ratio of use to injury is important. This ratio determines how likely an injury is. Annual injury estimates have been made, but usage numbers of the inflatable industry are very difficult to determine. To establish usage numbers the number of inflatable amusements in circulation would have to be known, as well as how often they are rented, and the average number of times they are used per rental.

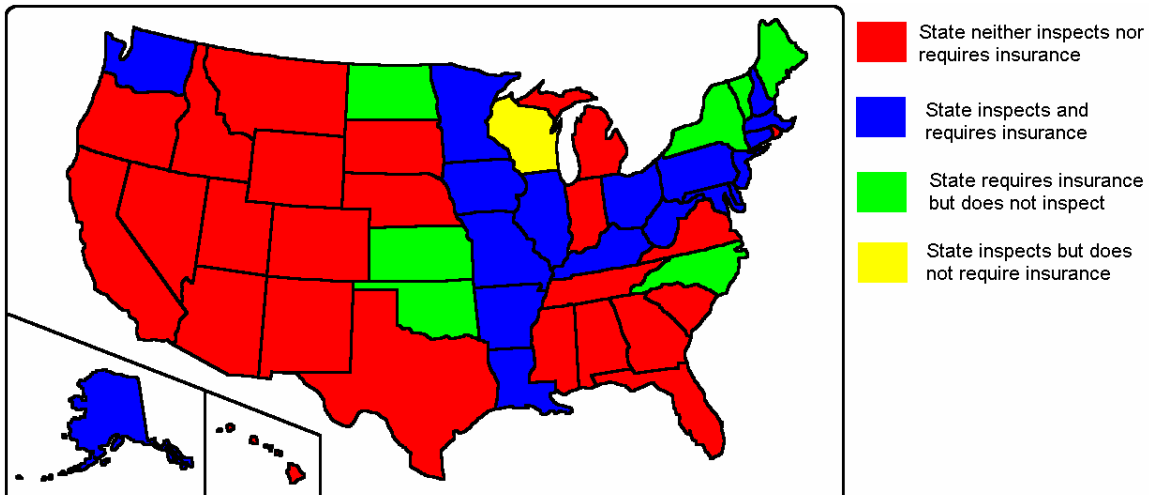
Due to the lack of regulations applying to inflatable companies, there is not even a count of how many companies exist. Also, due to the unknown lifespan of inflatable amusements, it is very difficult to determine how many inflatable amusements are still in use. Manufactures were unresponsive, so we were unable to obtain the production numbers. One state official estimated that inflatable usage had grown 600% in his state in the last few years. Other experts in the industry that believe the usage numbers have risen dramatically over the last few years, though no one else was willing to give an actual estimate.

9. Regulations, Legislation, and CPSC Bulletin

On May 23, 2001 the CPSC issued an [inflatable amusement safety bulletin](#). This bulletin outlined recommended setup and operation procedures for inflatable devices. It also mentioned that four states were working with the CPSC on investigating incidents that happened between March 1999 and February 2001. This bulletin stresses that rental companies, operators, and state safety officials should “closely follow manufacturers’ instructions and guidelines for operation and setup” (1).

Several states have begun working very closely with the CPSC for stricter inspections and safer rides. “Regulations in a number of states are becoming increasingly difficult and costly. Organizations such as NAARSO, ASTM and IIPGA can influence the development of standards and safety guidelines that can legitimize the inflatable industry and impact the current views of the insurance industry ([IIPGA, Industry Articles](#))”

Figure 25: Map of State Regulations



Source: http://moonwalkforum.com/members/stateregs/state_reg.htm

Inflatable attractions, which are regulated at a state level, vary from state to state.

As shown in Figure 25, twenty-four states do not inspect the inflatable devices that are being rented out to consumers nor require rental companies to carry a minimum insurance. Eighteen states require rental companies to have their devices inspected for certain requirements and to carry a minimum insurance which is usually 1 million dollars. Three of these eighteen states, Massachusetts, New Jersey, and Pennsylvania, were chosen to become model states for future regulation due to their strict laws and approach to the problem.

Massachusetts has adopted the ASTM-F2374-04 standard. It also requires owners of inflatable devices to carry insurance with a “minimum amount of \$2,000,000 in combined single limit bodily injury and property damage.” All inflatable devices have to be inspected prior to first use and yearly by state inspectors, which are state employees. Each device taller than 12 feet has to also be inspected at every setup and require an operator to be present while being used (MoonwalkForum.com).

New Jersey has strict laws applying to both manufacturers and rental companies. Before manufacturers can sell inflatable attractions in New Jersey, they have to submit an application for type certification, which includes calculations, non-destructive testing, and ride analysis. Rental companies are required to carry at least a \$1,000,000 minimum insurance per occurrence. All inflatable attractions have to be inspected prior to first use, yearly and an operational inspection will be performed several times a year by a state inspector, which is a state employee. It is required that rental companies submit an itinerary to the state for each attraction. Each entrance and exit for attraction has to be staffed by an operator. New Jersey also has certain anchorage requirements, requires operators to have a data plate on the attraction and requires a sign in English and another

language explaining the rider reporting requirement to be posted. Rental companies are required to follow a set procedure if any incident occurs involving a “ride-related injury or complaint” (MoonwalkForum.com).

Pennsylvania requires manufacturers and rental companies to comply with ASTM standards. Rental companies are required to have a minimum insurance of “at least \$100,000 per occurrence and \$300,000 in the aggregate for inflatables.” It is also required that “when an owner submits an accident report to the owner’s insurance company, a copy of those reports shall be sent to the state.” Rental companies are required to immediately close the inflatable attraction down if there is a “serious injury, death or fire occurs” (MoonwalkForum.com).

It is required by the Pennsylvania that rental companies give the state an itinerary at least fifteen days in advance of an event. Inflatable attractions have to be inspected by a qualified inspector, prior to first use, every 30 days, and “prior to operating at a public event.” These inspectors are not state employees. Pennsylvania does have a variance which “allows a business that rents an inflatable ride for a birthday party, picnic or similar non-public non-profit event to inspect the inflatable ride on a monthly basis, file an inspection report with the state and be exempted from the requirements it inspect the inflatable ride at each new location and provide an itinerary with respect to the rental” (MoonwalkForum.com).

Currently, thirty one states do not require inflatable attractions to be inspected. In at least some cases, this is due to financial constraints. ([Doman](#)) Pennsylvania’s system for inspection is a cost effective method for states since the inspectors are only state certified. Inspections decrease the chances of unsafe or improperly maintained inflatable

attractions being used by the public.

10. Lawsuits

With injuries and fatalities occurring on inflatable amusements it is not surprising that lawsuits occur. These lawsuits highlight the problems with the inflatable industry. The following is an example of one of the lawsuits found on rideaccidents.com that has already resulted from an injury relating to an inflatable amusement:

Report: at least 14 Titanic inflatable slides have collapsed

(Wednesday, November 26, 2003) - In Waterloo, Iowa, a court case began involving the parents of a 7-year-old girl who was injured in an accident involving a Titanic inflatable slide. She fell 25 feet and landed on cement when the slide, operated by Midwest Amusements of Minnesota, collapsed. The accident happened at Waterloo's National Cattle Congress fair in 2002.

The lawsuit alleges that the operator failed to follow safety instructions for the ride, and that the ride attendant allowed six people on board when the maximum capacity was only four. It also claims that the ride had started to tip hours earlier, and the attendant had grabbed the ride to keep it from toppling. The attorney representing the family claims that Midwest Amusements did not get a copy of the ride's manual and did not know how to properly set up the ride. He said the instruction book warned of catastrophic failure if the ride was overloaded, and that the warning featured an illustration of people falling from the ride.

Midwest Amusements said the inflatable slide passed a state inspection before the fair, and that they had no reason to suspect it would

collapse. The defense attorney representing Midwest says the company had used the slide for two years without any problems.

Reports cited by the plaintiffs' attorney show that at least 14 inflatable slides with the Titanic design have collapsed in recent years.

Other lawsuits have been filed. Due to the nature of the industry, these suits have been against both manufacturers and rental companies. There has been at least one case of a victim's family considering suing a host's home insurance over an incident that happened at a backyard party ([IDI 051005CCC1014](#)).

11. Home Use Inflatables

Recently inflatable bounce houses, slides, and obstacle courses have become available at retail stores around the country. These inflatables are smaller and less-expensive than the ones often rented out. A typical rental bounce house costs around \$1,700 ([Claiborne](#)). A home use inflatable typically costs between \$200 and \$400. Home use inflatables are currently mostly meant for young children and have lower weight allowances than their rental counterparts.

11.1 The Potential Dangers of Home Use Inflatables

Because of their similar shapes and uses home inflatables have many of the same potential dangers as rental inflatables. This includes collisions, blow-overs, falls from slides, etc. In addition, home inflatables have other safety concerns. One of which is a lack of trained supervision that some rental companies provide. Untrained parents will be the only supervision children will likely get. It is also likely that these inflatables may be used unsupervised entirely, either when parents are not home or are occupied. A lack of supervision is likely to lead to misuse and increase the risk of injury.

Another concern is that home bounce houses are shorter than rental ones and usually lack a roof. Therefore, they may have difficulty containing users who fall against the bounce house walls. During our product testing, our simulations of a consumer falling against the wall did not consistently contain the consumer, especially when the test consumer was bouncing. (It should be noted that the test user was above the manufacturer recommended maximum weight.) This problem is likely to become more pronounced as the sides wear and stitching comes loose.

Figure 26: Home Inflatable Testing



Figure 27: Ripped Stitching on Home Inflatable



In addition, some home inflatables lack a [GFCI](#) and therefore may pose an electric shock hazard. Some of these inflatables have short cords (12 feet or less) increasing the likelihood of extension cords being used. Lengthening power cords and adding GFCIs to home inflatables would greatly decrease the risk of electric shock.

12. Ground Fault Circuit Interrupters

Concerns have been raised about the recently manufactured inflatable devices meant for home purchase. These cheaper inflatables are now available for consumer purchase in large retail stores. Some of these inflatables do not have built in Ground Fault Circuit Interrupter (GFCI). GFCIs are safety devices designed to protect the user from electric shock by shutting off power if a ground fault occurs. “An unintentional electric path between a source of current and a grounded surface is referred to as a ‘ground-fault’ ... Ground faults occur when current is leaking somewhere, in effect; electricity is escaping to the ground. How it leaks is very important. If your body provides a path to the ground for this leakage, you could be injured, burned, severely shocked, or electrocuted ([CPSC GFCI Fact Sheet](#)).

According to the National Electric Code, “In homes built to comply with the National Electrical Code (the Code), GFCI protection is required for most outdoor receptacles (since 1973)...” ([CPSC GFCI Fact Sheet](#)). However, as it only became mandatory after 1973, many older homes do not meet this requirement.

Since many older homes do not have GFCIs built into their outdoor outlets there is great concern for safety. With consumers being unlikely to take down inflatables every time it rains, it is foreseeable that extension cords could be left in and used in puddles. If a puddle were to be electrified from a fault with the electric fan, power cord, or junction of the power cord, barefoot children would be at great risk of electric shock by coming into contact with the puddle.

Although the GFCI is relatively cheap to build into the product, approximately \$17 according to a CPSC official, some companies do not provide this safety feature.

Ground fault circuit protection can be part of a circuit breaker or built within a receptacle. The circuit breaker protects the entire circuit while receptacles can be wired to protect only the individual device and/or to also protect the receptacles on the load side of the GFCI device... It is also a good practice to limit exposure of connectors and tools to excessive moisture by using watertight or sealable connectors ([Steel Toe: Electrical Safety](#)).

One remedy to the lack of GFCIs is for customers to purchase their own portable GFCI. This add-on may prevent electric shock. However, many consumers will not buy such add-ons, especially those unfamiliar with GFCIs. Therefore, as Ground Fault Circuit Interrupters are a crucial part of electrical safety for outside fans and blowers, it is our recommendation that the CPSC enforce mandatory GFCIs installed on all inflatables.

Figure 28: Portable Ground Fault Circuit Interrupter



Source:

http://www.marinedepot.com/aquarium_miscellaneous_tower_shock_buster_gfci_adapter_cord_set_inline.asp?ast=&key

13. Standards

In the world of manufacturing, the greatest assurance of quality comes from adhering to specific industry standards. Any company can *say* their product is of the highest quality, but adherence to standards serves as a better indicator. ASTM, ANSI, UL, and ISO are all examples of such standards.

In the world of inflatable amusements there are specific standards that apply to their manufacture as well as training of operators. For example, ASTM F2374-04 “Standard Practice for Design, Manufacture, Operation, and Maintenance of Inflatable Amusement Devices”, as its title says, covers much of the needed information for the standard practice of design, manufacture, operation, and maintenance of these amusements. Any company dealing with inflatable amusements that does not adhere to this standard should raise a red flag with safety officials and inspectors. Similarly, another standard that should be carefully adhered to is ASTM F1159-03a “Standard Practice for Design and Manufacture of Patron Directed, Artificial Climbing Walls, Dry Slide, Coin Operated and Purposeful Water Immersion Amusement Rides and Devices and Air-Supported Structures.” ([ASTM](#))

In addition to ASTM standards, companies should be ISO certified. There are many different classifications of ISO, for example ISO 9000, ISO 9001, and ISO14001 each applying to a different aspect of quality. The general premise of ISO is that a company calls out exactly what steps they use to perform a function. Once a year an audit is conducted by ISO officials who make sure that the company follows the steps of the ISO standard exactly. This assures that each product is manufactured to exacting standards to reduce defects caused by human error.

13.1 UL Standards

When a product operates with electricity, it needs to be third party tested for electrical safety. Underwriters Laboratories, Inc. is a Nationally Recognized Testing Laboratories (NRTL) that certifies that electrical devices have passed the proper safety standards that apply to their classification of product. This is especially important for appliances intended for home use. UL testing covers important issues such as grounding, proper wire sizes, strain relief, and other safety features. The UL certification or other third party certification label should be visibly listed on each product. Companies manufacturing or selling products in the US are typically very good about disclosing the standards they adhere to. Any company that won't release this information may not be certified for safety and should concern officials.

Underwriters Laboratories Inc, (UL), is a common name you look for on electrical equipment when you are considering safety. This is why we were concerned that currently the fans and blowers of inflatable amusements are not UL listed. It was later discovered that these blowers and fans were formerly covered by UL507, but this listing was then changed to exclude them.

1.8 These requirements do not cover:

k) Blower or inflators intended for use with inflatable bouncing toys or similar children's products.

[\(UL 507 ISBN 0-7629-0488-7 Electric Fans, 16\)](#)

We have since determined that the fans and blowers are technically UL 507 listed, however they are not listed for the specific application of inflatable amusement rides.

This poses a problem of deception with companies claiming to have UL listed fans and

blowers, which is technically true, yet UL is not certifying them for what they are being used for.

It is recommended that these fans and blowers be properly UL listed. To do this we recommend the creation of a new subsection of UL507 that applies strictly to the use of the fans and blowers for inflatables amusements. (In this subsection additional requirements would be added to ensure that the outdoor use fan or blower is suitable for use with inflatables.) This is crucial to ensure the safety of these devices. A UL listing or other third party certification would prevent a company from claiming certification, while selling devices unsuited for use with inflatables.

13.2 ASTM Standards

ASTM International, formerly American Society for Testing and Materials, was founded in 1898. According to its website, this non-profit organization “provides a global forum for the development and publication of voluntary consensus standards for materials, products, systems, and services.” ASTM has over 30,000 members representing many aspects of industry, from developer to consumer. Together these members create standards accepted by business and academia throughout the world.

The ASTM standards that apply to the inflatable industry include: F2374-04, F698-94(2000), F747-97, F770-93(2000), F853-05, F893-05, F1159-03a, F1193-04b, F846-92(2003). These standards are important for the inflatable amusement industry for various reasons as described in their scope and outlined below.

F2374-04 Standard Practice for Design, Manufacture, Operation, and Maintenance of Inflatable Amusement Devices

1. Scope

1.1 This practice applies to the design, manufacture, and operation of inflatable amusement devices and their associated operating environments.

1.2 This practice specifically excludes inflatable devices that are used for professional exhibition or stunt work; safety and rescue activities; aerial or aviation structures or devices; exhibit floats; or similar inflatable devices.

[\(ASTM F2374-04\)](#)

F698-94(2000) Standard Specification for Physical Information to be Provided for Amusement Rides and Devices**1. Scope**

1.1 This specification covers the minimum requirements for information that shall be provided by the manufacturer or seller of new amusement rides or devices as a part of the initial sale or transfer to the first end user.

1.2 This specification does not apply to the sale or transfer of used amusement rides and devices.

[\(ASTM F698-94\(2000\)\)](#)

F747-97 Standard Terminology Relating to Amusement Rides and Devices

This standard covers the terminology needed to understand several of the other ASTM standards.

F770-93(2000) Standard Practice for Operation Procedure for Amusement Rides and Devices

1. Scope

1.1 This practice establishes information for operating procedures of amusement rides and devices.

[\(ASTM F770-93\)](#)

F853-05 Standard Practice for Maintenance Procedures for Amusement Rides and Devices**1. Scope**

1.1 This practice establishes information for maintenance procedures of amusement rides and devices.

[\(ASTM F853-05\)](#)

F893-05 Standard Guide for Inspection of Amusement Rides and Devices**1. Scope**

1.1 This guide covers the inspections of amusement rides and devices during prototype development, production manufacturing, installation or erection, following major modification or overhaul, and during operation and maintenance periods.

[\(ASTM F893-05\)](#)

F1159-03a Standard Practice for Design and Manufacture of Patron Directed, Artificial Climbing Walls, Dry Slide, Coin Operated and Purposeful Water Immersion Amusement Rides and Devices and Air-Supported Structures**1. Scope**

1.1 This practice establishes information and procedures for the design and manufacture of patron directed amusement rides or devices (for example, go karts, bumper cars, bumper boats), artificial climbing walls, dry slides, coin operated rides, and amusement rides and devices that involve the purposeful immersion of the patron's body partially or totally in the water and involve more than incidental patron contact (for example, pools, water slides, lazy rivers, interactive aquatic play devices), and air-supported structures.

[\(ASTM F1159-03a\)](#)

F1193-04b Standard Practice for Amusement Ride and Device Manufacturer Quality Assurance Program and Manufacturing Requirements

1. Scope

1.1 This practice establishes the minimum requirements for a quality assurance program and the manufacturing of amusement rides and devices (including major modifications).

[\(ASTM F1193-04b\)](#)

F846-92(2003) Standard Guide for Testing Performance of Amusement Rides and Devices

1. Scope

1.1 This guide covers the basic tests which shall be conducted on amusement rides and devices during prototype development, installation or erection, following major modifications, and during normal operation to determine that the performance of a given ride or device meets the manufacturer's specified design criteria.

[\(ASTM F846-92\)](#)

After reviewing these ASTM standards, we concluded that having a large number of separate standards was inconvenient. It would be far more efficient to have one all encompassing standard for commercial use inflatable amusement rides. We recommend revising the main existing standard for inflatables, F2374-04 Standard Practice for Design, Manufacture, Operation, and Maintenance of Inflatable Amusement Devices, to include the most relevant parts of the other standards listed above.

As home inflatables are different products than those intended for rentals, they should be held to different standards. Therefore we also recommend developing an ASTM standard specifically for home use inflatables

14. Consumer Education

Inflatable amusements like many products are much safer when used correctly. Many incidents on these products are at least partially due to improper use. Occupants of bounce houses have hurt themselves attempting flips. Parents have allowed too many children or children of mixed ages into inflatables causing children to get hurt by collisions. Children have jumped up and down on slides that have tipped over. One of the members of this group has even witnessed teenagers intentionally trying to flip a bounce house while inside in plain sight of their parents.

Educating consumers could help prevent incidents such as these. The CPSC already has several mechanisms in place for educating consumers about the dangers of certain products. Safety bulletins video releases, and other mediums could be used to teach consumers how to avoid unsafe inflatables, to avoid overcrowding and excess wind, and to supervise children.

Prominent warning signs are another way of educating consumers. The number of incidents relating to overcrowding and high winds could be lowered by making it very clear to consumers how many occupants should be inside and how much wind is too much. Unfortunately, these labels are sometimes located far away from the entrances, where they can be difficult to see and easy to ignore. Therefore we recommend that inflatable amusements be required to display prominent warning labels with occupancy and maximum wind information near all entrances.

15. Applying Playground Safety to Inflatable Amusements

Playgrounds have much in common with inflatable amusements. They are both primarily for children; used by multiple participants at once; and have numerous reports of children being injured on them. Because of these similarities it would not be unreasonable to apply standards for playground equipment to address similar injuries reported with the use of inflatable amusements.

15.1 Use Zone

When dealing with inflatable amusements, as with playgrounds, it is important to consider the area around the device. A use zone for playground equipment is defined in the CPSC's Handbook for Public Playground Safety as "the surface under and around a piece of equipment onto which a child falling from or exiting from the equipment would be expected to land." (3). The use zone for an inflatable amusement could be determined in the same manner that use zones for playground equipment are derived in the handbook. We recommend that use zones be determined.

15.2 Critical Height

One of the factors determining the severity of a fall and the subsequent injury is resiliency of the surface on which the victim lands. Critical height, defined in the Handbook for Public Playground Safety as, "the fall height below which a life-threatening head injury would not be expected to occur," (2), is an important property of the surfacing material or safety mats, if used. The handbook recommends that the depth of the surface material a user would fall on be resilient to at least the maximum height a

victim could fall. For example, 6 inches of coarse sand has a critical height of 5 feet. Therefore it would be an acceptable fill, at the specified depth for a playground with a four foot slide but not for an eight foot slide.

As users have often fallen out/off of inflatable amusements much like they do when using playground equipment, it would be logical to require similar fill/mats to surround the amusement. Therefore we recommend requiring/encouraging fill/mats with a resiliency equal to or greater than the maximum height which a user could fall. The surfacing should be placed around the [use zone](#) of inflatable amusements. This would help guard against the life-threatening head injuries which have been responsible for several deaths.

15.3 Guard Rails

Guard rails, found on playground and inflatable slides, keep riders from falling off the side while descending. At least one fatality can be blamed on insufficient guard rails. A 15 year old male died after falling from the slide portion of an inflatable obstacle course and landing on his head. ([IDI 030522CCC2463](#)) Playground slides have recommended guard rail heights to prevent such injuries from occurring.

Playground regulations for guard rails cannot be directly applied to an inflatable amusement ride. Playground rails are rigid, unlike an inflatable rail. The inflatable rail can deform, making it easier for riders to roll over them. Therefore inflatable rails would have to be even higher than those recommended for metal, plastic, and wooden slides. The exact height would depend on the size of the intended users, the air-pressure in the inflatable amusement, and other factors. We recommend that future work be done to

determine safe guard rail heights.

15.4 Entrapment

Entrapment, which is defined in the CPSC’s Handbook for Public Playground Safety as, “Any condition that impedes withdrawal of a body or body part that has penetrated an opening” (3) is a potential danger on both playgrounds and inflatables. Netting around bounce houses has been responsible for at least one broken wrist ([IDI 000928HEP6882](#)) and one lost tooth ([IDI 030620CCN0650](#)). In each case, the injured body part became ensnared while the victim was using the bounce house. While it may be difficult to prevent a tooth from becoming caught, smaller holes in the netting would keep out children’s wrists. We recommend that further research be done into entrapment possibilities in inflatable amusements to determine standards for netting sizes as well as acceptable spaces between different pieces of the inflated structure.

16. Summary of Recommendations for a Safer Inflatable Amusement

Industry

- **States should consider adopting New Jersey’s regulations.**
 - Require operators for all inflatable rentals.
 - Inspect each inflatable annually.
 - Inspect each inflatable before all public events.
 - Require that each rental company submit an itinerary to the state.
 - Require minimum insurance policy for rental companies.
 - Actively enforce legislation.

- **ASTM International should update its standards.**
 - ASTM F2374-04 should be updated to contain all information for rental inflatables.
 - A new standard should be created for home inflatables.

- **Underwriter’s Laboratory should certify fans and blowers for use with inflatables.**
 - A new subsection of UL 507 should be made to certify blowers for use with inflatable amusements.
 - This subsection should require a GFCI.

- **Playground requirements should be adapted to fit inflatable amusements.**

- The padding/fill surrounding an inflatable should meet critical height recommendations.
- Guard rails on slides should have a required minimum height.
- Inflatables should be free off entrapment hazards.

- **Visible warning labels should be mandatory.**
 - These labels should clearly state maximum occupancy and maximum wind speed.
 - Warning labels should be placed near entrances.

- **The CPSC should educate consumers.**
 - Help consumers recognize unsafe inflatable setups.
 - Teach consumers to cease use of inflatables during excessive wind.
 - Encourage parents to supervise their children, especially when no operator is present.

17. Future Research

Due to the limited time we had to complete this project, we were not able to give some topics the full time they deserve. Other topics in this section were outside the scope of our project, but could provide useful. The following areas should be further researched by the next CPSC person in charge of research into inflatable amusements:

- How insurance companies feel about the industry and how this affects the way rental companies operate.
- Staking and anchoring requirements, whether manufacturer recommendations are appropriate, and how soil conditions affect staking.
- Concerns unique to inflatable water slides, including the increased risk of electric shock.
- How carnivals operate inflatables and how it affects safety.
- How often these amusements are being used and how usage has changed over the years.
- Where inflatables are being made and what standards they are being held to in foreign countries

18. References

Ackerman, Charles J. Telephone interview. 24 Oct. 2005. Charles J. Ackerman, Quality Assurance Manager, FCI USA, Inc. Electrical Power Interconnect, Manchester, NH

Anonymous source. Telephone interview. Nov.-Dec. 2005.

"Are Bounce Houses Becoming a Thing of the Past?" Association of Inflatable Rental Company Operators. 02 Feb. 2005. 07 Dec. 2005 <<http://www.airco.org/forum/index.php?&act=ST&f=4&t=2611&mode=show&st=>>.

Association of Inflatable Rental Company Operators. Nov.-Dec. 2005 <<http://www.airco.org/>>.

ASTM International - Standards Worldwide. Dec. 2005 <<http://www.astm.com/cgi-bin/SoftCart.exe/index.shtml?E+mystore>>.

Barber, Jim. Telephone interview. Nov.-Dec. 2005.

Berg, Bruce L. Qualitative research methods for the social sciences. 5th ed. Boston: Pearson, 2004.

"Bouncey Boxing - More opinions needed" Association of Inflatable Rental Company Operators. 07 Dec. 2005 < <http://www.airco.org/forum/index.php?showtopic=2358&view=findpost&p=21976> >.

Claiborne, Scottie. "Inflatable Insurance Insanity." Association of Inflatable Rental Company Operators. 2004. Nov.-Dec. 2005 <<http://www.airco.org/newsletter/hullaballoo1.php>>.

Doman, Mark. Telephone interview. Nov.-Dec. 2005.

"Do you own an Inflatable Boxing Attraction?" Association of Inflatable Rental

Company Operators. 20 Dec. 2004. 07 Dec. 2005 <<http://www.airco.org/forum/index.php?&act=ST&f=4&t=2358&mode=show&st=>>.

"Do you provide Unattended Rentals to Your Customers?" Association of Inflatable Rental Company Operators. 27 June 2005. 07 Dec. 2005 <<http://www.airco.org/forum/index.php?&act=ST&f=5&t=3777&mode=show&st=>>.

Fackler, Kathy. E-mail interview. 03 Nov. 2005.

Hardy, Courtney I. "WPI - Inflatable Amusement Device Project." E-mail to Jason Twitchell. 26 Oct. 2005.

"How Many Units do you have in Your Rental Fleet?" Association of Inflatable Rental Company Operators. 27 Nov. 2005. 07 Dec. 2005 <<http://www.airco.org/forum/index.php?&act=ST&f=4&t=4359&mode=show&st=>>.

"How Much Does Your Insurance Cost You Per Year?" Association of Inflatable Rental Company Operators. 07 Dec. 2005 <<http://www.airco.org/forum/index.php?&act=ST&f=3&t=3992&mode=show&st=>>.

"Industry Articles." Welcome to the Official Website of IIPGA. Oct. 2005 <http://www.iipga.com/members_only/april2004_articles.html>.

"Is Insurance really a Problem?" Association of Inflatable Rental Company Operators. 07 Dec. 2005 <<http://www.airco.org/forum/index.php?&act=ST&f=3&t=2683&mode=show&st=>>.

Joyce, Tom. "The Steel Toe : Electrical Safety." ELCOSH. Jan. 2006 <<http://images.google.com/imgres?imgurl=http://www.cdc.gov/elcosh/docs/d0100/d000135/plug.jpg&imgrefurl=http://www.cdc.gov/elcosh/docs/d0100/d000135/d000135.html&h=247&w=292&sz=20&tbnid=phZUuEtWsZ0J:&tbnh=93&tbnw>>

=111&hl=en&start=5&prev=/images%3Fq%3Dportab>.

Levenson, Mark. Personal interview. Oct.-Nov. 2005.

Levenson, Mark S. United States of America. U.S. Consumer Product Safety

Commission. Amusement Ride-Related Injuries and Deaths in the United States:

1987-2000. Aug. 2001. Sept. 2005

<<http://www.cpsc.gov/LIBRARY/Amus2001.pdf>>.

Levenson, Mark S. United States of America. U.S. Consumer Product Safety

Commission. Amusement Ride-Related Injuries and Deaths in the United States:

Update 2004. Sept. 2004. Sept. 2005

<<http://www.cpsc.gov/LIBRARY/Amus2004.pdf>>.

McCutcheon, Chuck. "Safety of Inflatable Amusements Is of Rising Concern."

Newhouse News Service 24 June 2005. Sept.-Oct. 2005

<<http://http://www.newhousenews.com/archive/mccutcheon062405.html>>.

Mooney, Mark. Telephone interview. Nov.-Dec. 2005.

National Association of Amusement Ride Safety Officials. Nov.-Dec. 2005

<<http://www.naarso.com/>>.

National Electronic Surveillance System. CPSCnet. 25 Oct. 2005.

RideAccidents.com. Sept. 2005 <<http://www.rideaccidents.com/>>.

"'ROAR' Responsible Operators of Amusement Rentals." Responsible Operators of

Amusement Rentals. Nov.-Dec. 2005 <<http://www.roarusa.org/default.asp>>.

Saferparks. Nov.-Dec. 2005 <<http://Saferparks.org>>.

"Safety Programs." Responsible Operators of Amusement Rentals. Nov.-Dec. 2005

<http://www.roarusa.org/Safety_Programs.asp>.

Shibilia, David. Telephone interview. Oct.-Nov. 2005.

"State Regulations." Moonwalkforum. Nov.-Dec. 2005

<http://moonwalkforum.com/members/stateregs/state_reg.htm>.

"UL 507 ISBN 0-7629-0488-7 Electric Fans." Underwriters Laboratories Inc.

Underwriters Laboratories Inc. Dec. 2005

<<http://ulstandardsinfontet.ul.com/scopes/0507.html>>.

United States of America. Consumer Product Safety Commission. GFCIs Fact Sheet. Jan.

2006 <<http://www.cpsc.gov/CPSCPUB/PUBS/99.html>>.

United States of America. Consumer Product Safety Commission. Handbook for Public
Playground Safety.

United States of America. Consumer Product Safety Commission. IDI 000928HEP6882.

Oct.-Nov. 2005.

United States of America. Consumer Product Safety Commission. IDI 030522CCC2463.

Oct.-Nov. 2005.

United States of America. Consumer Product Safety Commission. IDI 030620CCN0650.

Oct.-Nov. 2005.

United States of America. Consumer Product Safety Commission. IDI 050531CNE2459.

Oct.-Nov. 2005.

United States of America. Consumer Product Safety Commission. IDI 051005CCC1014.

Oct.-Nov. 2005.

United States of America. Consumer Product Safety Commission. IDI 890922CAA2423.

Oct.-Nov. 2005.

United States of America. Consumer Product Safety Commission. IDI 920625CWE6001.

Oct.-Nov. 2005.

United States of America. U.S. Consumer Product Safety Commission. Amusement Ride Safety Bulletin. 23 May 2001. Sept. 2005

<<http://www.cpsc.gov/LIBRARY/FOIA/FOIA02/os/amusemnt.PDF>>.

"What do you Offer to Customers?" Association of Inflatable Rental Company Operators.

11 Jan. 2004. 07 Dec. 2005 <[http://www.a-](http://www.a-irco.org/forum/index.php?&act=ST&f=4&t=17&mode=show&st=>)

[irco.org/forum/index.php?&act=ST&f=4&t=17&mode=show&st=>](http://www.a-irco.org/forum/index.php?&act=ST&f=4&t=17&mode=show&st=>).

"What Month do you Make the Most Money Renting Moonwalks?" Association of

Inflatable Rental Company Operators. 23 Oct. 2005. 07 Dec. 2005 <[http://www.a-](http://www.a-irco.org/forum/index.php?&act=ST&f=5&t=4196&mode=show&st=>)

[irco.org/forum/index.php?&act=ST&f=5&t=4196&mode=show&st=>](http://www.a-irco.org/forum/index.php?&act=ST&f=5&t=4196&mode=show&st=>).

"What Surface do you Most Commonly Setup Your Moonwalks on?" Association of

Inflatable Rental Company Operators. 02 July 2004. 07 Dec. 2005 <[http://www.a-](http://www.a-irco.org/forum/index.php?&act=ST&f=4&t=1241&mode=show&st=>)

[irco.org/forum/index.php?&act=ST&f=4&t=1241&mode=show&st=>](http://www.a-irco.org/forum/index.php?&act=ST&f=4&t=1241&mode=show&st=>).

"Would you buy Imported Units?" Association of Inflatable Rental Company Operators.

05 Oct. 2004. 07 Dec. 2005 <[http://www.a-](http://www.a-irco.org/forum/index.php?&act=ST&f=4&t=1867&mode=show&st=>)

[irco.org/forum/index.php?&act=ST&f=4&t=1867&mode=show&st=>](http://www.a-irco.org/forum/index.php?&act=ST&f=4&t=1867&mode=show&st=>).

"Would You Still Have Started This Business if the Insurance was Priced Like it is

Today?" Association of Inflatable Rental Company Operators. 07 Dec. 2005

<[http://www.a-](http://www.a-irco.org/forum/index.php?&act=ST&f=3&t=2585&mode=show&st=>)

[irco.org/forum/index.php?&act=ST&f=3&t=2585&mode=show&st=>](http://www.a-irco.org/forum/index.php?&act=ST&f=3&t=2585&mode=show&st=>).

"WPI's Unique Approach to Global Studies." Worcester Polytechnic Institute. Worcester

Polytechnic Institute. 04 Dec. 2005

<<http://www.wpi.edu/Academics/Depts/IGSD/About/unique.html>>.

Zientek, Mark. Telephone interview. Nov.-Dec. 2005.

19. Bibliography

"ROAR' Responsible Operators of Amusement Rentals." Responsible Operators of Amusement Rentals. Nov.-Dec. 2005 <<http://www.roarusa.org/default.asp>>.

Ackerman, Charles J. Telephone interview. 24 Oct. 2005. Charles J. Ackerman, Quality Assurance Manager, FCI USA, Inc. Electrical Power Interconnect, Manchester, NH

All American Inflatables. Sept. 2005 <<http://www.aainflatables.com/slides.htm>>.

Anonymous source. Telephone interview. Nov.-Dec. 2005.

ANSI. Sept. 2005 <<http://webstore.ansi.org/ansidocstore/default.asp>>.

"Are Bounce Houses Becoming a Thing of the Past?" Association of Inflatable Rental Company Operators. 02 Feb. 2005. 07 Dec. 2005 <<http://www.a-irco.org/forum/index.php?&act=ST&f=4&t=2611&mode=show&st=>>>.

"Articles." Welcome to the Official Website of IIPGA. Apr. 2004. Oct. 2005 <http://www.iipga.com/members_only/april2004_articles.html>.

Association of Inflatable Rental Company Operators. Nov.-Dec. 2005 <<http://www.a-irco.org/>>.

ASTM International - Standards Worldwide. Dec. 2005 <<http://www.astm.com/cgi-bin/SoftCart.exe/index.shtml?E+mystore>>.

Barber, Jim. Telephone interview. Nov.-Dec. 2005.

Berg, Bruce L. Qualitative research methods for the social sciences. 5th ed. Boston: Pearson, 2004.

"Bouncey Boxing - More opinions needed" Association of Inflatable Rental Company Operators. 07 Dec. 2005 <<http://www.a-irco.org/>>.

irco.org/forum/index.php?showtopic=2358&view=findpost&p=21976 >.

Claiborne, Scottie. "Inflatable Insurance Insanity." Association of Inflatable Rental Company Operators. 2004. Nov.-Dec. 2005 <<http://www.a-irco.org/newsletter/hullabaloo1.php>>.

"Committee G01/ Committee G01 on Corrosion of Metals." American Society for Testing and Materials (ASTM) International. American Society for Testing and Materials (ASTM) International. Jan. 2006 <<http://www.corrosion-doctors.org/InternetResources/ASTM.htm>>.

"CPSC Commissioners - a Chronology." US Consumer Product Safety Commission. Sept. 2005. U.S. Consumer Product Safety Commission. Sept. 2005 <<http://www.cpsc.gov/cpscpub/bios/comchron.html>>.

"Crackdown on Rock Climb Walls." Theme Park Insider. 01 Nov. 2003. Sept.-Oct. 2005 <<http://www.themeparkinsider.com/news/>>.

Death certificate database. CPSCnet. Oct.-Nov. 2005.

"Directory of North American Amusement Ride Safety Officials." Www.cpsc.gov. Sept. 2005 <<http://www.cpsc.gov/cpscpub/pubs/amuse.pdf>>.

Doman, Mark. Telephone interview. Nov.-Dec. 2005.

"Do you own an Inflatable Boxing Attraction?" Association of Inflatable Rental Company Operators. 20 Dec. 2004. 07 Dec. 2005 <<http://www.a-irco.org/forum/index.php?&act=ST&f=4&t=2358&mode=show&st=>>>.

"Do you provide Unattended Rentals to Your Customers?" Association of Inflatable Rental Company Operators. 27 June 2005. 07 Dec. 2005 <<http://www.a-irco.org/forum/index.php?&act=ST&f=5&t=3777&mode=show&st=>>>.

Extreme Bounce. Sept. 2005 <<http://www.extreme-bounce.com>>.

"F2374-04 Standard Practice for Design, Manufacture, Operation, and Maintenance of Inflatable Amusement Devices." ASTM International. Oct. 2005 <http://www.astm.org/cgi-bin/SoftCart.exe/DATABASE.CART/REDLINE_PAGES/F2374.htm?L+mystore+rqxn1949>.

"F2374-04 Standard Practice for Design, Manufacture, Operation, and Maintenance of Inflatable Amusement Devices." ASTM International. Sept. 2005 <http://www.astm.org/cgi-bin/SoftCart.exe/DATABASE.CART/REDLINE_PAGES/F2374.htm?L+mystore+afjb2331+1127100787>.

Fackler, Kathy. E-mail interview. 03 Nov. 2005.

"Frequently Asked Questions." US Consumer Product Safety Commission. Sept. 2005. U.S. Consumer Product Safety Commission. Sept. 2005 <<http://www.cpsc.gov/about/faq.html>>.

Goslow, Brian. "The Wildest Ride of Summer." Worcester Magazine 10 June 2004. Sept.-Oct. 2005 <http://www.worcestermag.com/archives/2004/06-10-04/current/city_desk.shtml>.

Hacker, Diana. A writer's reference. 5th ed. Boston: Bedford/St. Martin's, 2003.

Hardy, Courtney I. "WPI - Inflatable Amusement Device Project." E-mail to Jason Twitchell. 26 Oct. 2005.

"How Many Units do you have in Your Rental Fleet?" Association of Inflatable Rental Company Operators. 27 Nov. 2005. 07 Dec. 2005 <<http://www.a->

irco.org/forum/index.php?&act=ST&f=4&t=4359&mode=show&st=>.

"How Much Does Your Insurance Cost You Per Year?" Association of Inflatable Rental Company Operators. 07 Dec. 2005 <<http://www.a-irco.org/forum/index.php?&act=ST&f=3&t=3992&mode=show&st=>>>.

"How Safe Are Jump Houses, Inflatable Rides?" Local6.com. 26 Oct. 2005. Sept.-Oct. 2005 <<http://www.local6.com/family/5179428/detail.html>>.

In-Depth Investigation File. CPSCnet. Oct.-Nov. 2005.

"Industry Articles." Welcome to the Official Website of IIPGA. Oct. 2005 <http://www.iipga.com/members_only/april2004_articles.html>.

"Inflatable Rental Biz Questions." Association of Inflatable Rental Company Operators. 16 Nov. 2005. 08 Dec. 2005 <<http://www.a-irco.org/forum/index.php?showtopic=4306>>.

Injury or Potential Injury Incident File. CPSCnet. Oct.-Nov. 2005.

International Inflatable Products and Games Association. Sept.-Oct. 2005 <<http://www.iipga.com/sitemap.html>>.

"Is Insurance really a Problem?" Association of Inflatable Rental Company Operators. 07 Dec. 2005 <<http://www.a-irco.org/forum/index.php?&act=ST&f=3&t=2683&mode=show&st=>>>.

Jan. 2006 <<http://images.google.com/imgres?imgurl=http://www.aopartyrentals.com/images/Corporate%2520Events/corporate%2520event%2520inflatable%2520boxing%25201.jpg&imgrefurl=http://www.aopartyrentals.com/corporateevents.shtml&h=1215&w=1800&sz=906&tbnid=2CKxdCGL18oJ:&tbnh=101&tbnw=150&hl=en&s>>

start=1&prev=/images%3Fq%3Dboxing%2Binflatable%26svnum%3D10%26hl%3Den%26lr%3D%26safe%3Doff%26sa%3DG>.

Jan. 2006 <http://muslimfest.net/images/inflatable_rental_obstacle_course_lrg.jpg>.

Jan. 2006 <<http://newyorkskylineent.com/Inflatable%20Rock%20Wall.jpg>>.

Jan. 2006 <<http://www.adventures-n-fun.com/castleprimary.jpg>>.

Jan. 2006 <<http://www.apartywithus.com/images/Super-Slide-drop-shadow.jpg>>.

Jan. 2006 <http://www.totalrebound.com/images/gamepix/Human_Slingshot.jpeg>.

Jan. 2006

<http://www.vanderbilt.edu/studentlife/photos/greekweek05/images/greek05_07.jpg>.

Joyce, Tom. "The Steel Toe : Electrical Safety." ELCOSH. Jan. 2006

<<http://images.google.com/imgres?imgurl=http://www.cdc.gov/elcosh/docs/d0100/d000135/plug.jpg&imgrefurl=http://www.cdc.gov/elcosh/docs/d0100/d000135/d000135.html&h=247&w=292&sz=20&tbnid=phZUuEtWsZ0J:&tbnh=93&tbnw=111&hl=en&start=5&prev=/images%3Fq%3Dportab>>.

Levenson, Mark. Personal interview. Oct.-Nov. 2005.

Levenson, Mark S. United States of America. U.S. Consumer Product Safety

Commission. Amusement Ride-Related Injuries and Deaths in the United States: 1987-2000. Aug. 2001. Sept. 2005

<<http://www.cpsc.gov/LIBRARY/Amus2001.pdf>>.

Levenson, Mark S. United States of America. U.S. Consumer Product Safety

Commission. Amusement Ride-Related Injuries and Deaths in the United States: 2002 Update. Aug. 2002. Sept. 2005

- <http://www.cpsc.gov/LIBRARY/Amus2002.pdf>.
- Levenson, Mark S. United States of America. U.S. Consumer Product Safety Commission. Amusement Ride-Related Injuries and Deaths in the United States: 2003 Update. Nov. 2003. Sept. 2005
- <http://www.cpsc.gov/LIBRARY/Amus2003.pdf>.
- Levenson, Mark S. United States of America. U.S. Consumer Product Safety Commission. Amusement Ride-Related Injuries and Deaths in the United States: 2005 Update. 7 Sept. 2005. 7 Oct. 2005
- <http://www.cpsc.gov/library/amus2005.pdf>.
- Levenson, Mark S. United States of America. U.S. Consumer Product Safety Commission. Amusement Ride-Related Injuries and Deaths in the United States: Update 2004. Sept. 2004. Sept. 2005
- <http://www.cpsc.gov/LIBRARY/Amus2004.pdf>.
- Martinez, Leandra. "Rental Essentials: The Inflatable Industry Gets Serious About Safety." Special Events Magazine. 1 Aug. 2005. Sept. 2005
- http://specialevents.com/operations/events_playing_safe_20050807/.
- Maxwell, Joseph Alex. Qualitative research design an interactive approach. 2nd ed. Thousand Oaks, CA: Sage Publications, 2005.
- McCutcheon, Chuck. "Safety of Inflatable Amusements Is of Rising Concern." Newhouse News Service 24 June 2005. Sept.-Oct. 2005
- <http://http://www.newhousenews.com/archive/mccutcheon062405.html>.
- Mooney, Mark. Telephone interview. Nov.-Dec. 2005.
- Mordini, Dan. "Re: Fan Blowers for Amusement Park Rides for Kids Etc." E-mail to

Dave Shibilila. 25 Oct. 2005.

National Association of Amusement Ride Safety Officials. Nov.-Dec. 2005
<<http://www.naarso.com/>>.

National Electronic Surveillance System. CPSCnet. 25 Oct. 2005.

"Online Certifications Directory." Underwriters Laboratories Inc. Sept.-Oct. 2005
<<http://database.ul.com/cgi-bin/XYV/template/LISEXT/1FRAME/index.htm>>.

Phelan, Kim, ed. "Riding on Air, part 2: Experts Say Industry Initiative Will Produce Best Regs For Inflatables." Rental Pulse. 10 Mar. 2003. Sept. 2005
<<http://www.rentalpulse.com/article.asp?ARTID=942>>.

"Reports." Consumer Product Safety Commission. Sept. 2005
<<http://http://www.cpsc.gov/cpscpub/pubs/reports.html>>.

RideAccidents.com. Sept. 2005 <<http://www.rideaccidents.com/>>.

Saferparks. Nov.-Dec. 2005 <<http://Saferparks.org>>.

"Safety Programs." Responsible Operators of Amusement Rentals. Nov.-Dec. 2005
<http://www.roarusa.org/Safety_Programs.asp>.

Sept. 2005
<<http://www.agriculture.state.pa.us/agriculture/lib/agriculture/ridesmeasuresfiles/inflatablestudymaterialletter12-14-04.pdf>>.

Shibilila, David. Telephone interview. Oct.-Nov. 2005.

"Standards Catalog." UL's Standards for Safety. Sept.-Oct. 2005
<<http://ulstandardsinfonet.ul.com/catalog/stdscatframe.html>>.

"Starter Package." Extreme Bounce. Sept. 2005 <<http://www.extreme-bounce.com/product.php>>.

"State Regulations." Moonwalkforum. Nov.-Dec. 2005

<http://moonwalkforum.com/members/stateregs/state_reg.htm>.

"Testimony of the Honorable Hal Stratton." U.S. Consumer Product Safety Commission.

Sept. 2005 <<http://www.cpsc.gov/pr/trans.pdf>>.

"Tower GFCIs - Shock Buster Portable & 3-Outlet Electrical Cord, Inline Cord Set."

Marine Depot. 21 Nov. 2005

<http://www.marinedepot.com/aquarium_miscellaneous_tower_shock_buster_gfci_adapter_cord_set_inline.asp?ast=&key>.

"UL 507 ISBN 0-7629-0488-7 Electric Fans." Underwriters Laboratories Inc.

Underwriters Laboratories Inc. Dec. 2005

<<http://ulstandardsinfontet.ul.com/scopes/0507.html>>.

United States of America. Consumer Product Safety Commission. GFCIs Fact Sheet. Jan.

2006 <<http://www.cpsc.gov/CPSCPUB/PUBS/99.html>>.

United States of America. Consumer Product Safety Commission. Handbook for Public Playground Safety.

United States of America. Consumer Product Safety Commission. IDI 000928HEP6882.

Oct.-Nov. 2005.

United States of America. Consumer Product Safety Commission. IDI 030522CCC2463.

Oct.-Nov. 2005.

United States of America. Consumer Product Safety Commission. IDI 030620CCN0650.

Oct.-Nov. 2005.

United States of America. Consumer Product Safety Commission. IDI 050531CNE2459.

Oct.-Nov. 2005.

United States of America. Consumer Product Safety Commission. IDI 051005CCC1014.
Oct.-Nov. 2005.

United States of America. Consumer Product Safety Commission. IDI 890922CAA2423.
Oct.-Nov. 2005.

United States of America. Consumer Product Safety Commission. IDI 920625CWE6001.
Oct.-Nov. 2005.

United States of America. U.S. Consumer Product Safety Commission. Amusement Ride
Safety Bulletin. 23 May 2001. Sept. 2005
<<http://www.cpsc.gov/LIBRARY/FOIA/FOIA02/os/amusemnt.PDF>>.

"Unregulated Products." US Consumer Product Safety Commission. Sept. 2005. U.S.
Consumer Product Safety Commission. Sept. 2005
<<http://www.cpsc.gov/BUSINFO/unreg.html>>.

U.S. Consumer Product Safety Commission. 6 Oct. 2005. U.S. Consumer Product Safety
Commission. Sept. 2005 <<http://www.cpsc.gov/>>.

"Welcome to the Official Website of IIPGA." Iipga.com. Sept. 2005
<http://www.iipga.com/members_only/june2004_articles.html>.

"What do you Offer to Customers?" Association of Inflatable Rental Company Operators.
11 Jan. 2004. 07 Dec. 2005 <[http://www.a-
irco.org/forum/index.php?&act=ST&f=4&t=17&mode=show&st=>](http://www.a-irco.org/forum/index.php?&act=ST&f=4&t=17&mode=show&st=>)>.

"What Month do you Make the Most Money Renting Moonwalks?" Association of
Inflatable Rental Company Operators. 23 Oct. 2005. 07 Dec. 2005 <[http://www.a-
irco.org/forum/index.php?&act=ST&f=5&t=4196&mode=show&st=>](http://www.a-irco.org/forum/index.php?&act=ST&f=5&t=4196&mode=show&st=>)>.

"What Surface do you Most Commonly Setup Your Moonwalks on?" Association of

Inflatable Rental Company Operators. 02 July 2004. 07 Dec. 2005 <<http://www.a-irco.org/forum/index.php?&act=ST&f=4&t=1241&mode=show&st=>>.

"Would you buy Imported Units?" Association of Inflatable Rental Company Operators. 05 Oct. 2004. 07 Dec. 2005 <<http://www.a-irco.org/forum/index.php?&act=ST&f=4&t=1867&mode=show&st=>>.

"Would You Still Have Started This Business if the Insurance was Priced Like it is Today?" Association of Inflatable Rental Company Operators. 07 Dec. 2005 <<http://www.a-irco.org/forum/index.php?&act=ST&f=3&t=2585&mode=show&st=>>.

"WPI's Unique Approach to Global Studies." Worcester Polytechnic Institute. Worcester Polytechnic Institute. 04 Dec. 2005 <<http://www.wpi.edu/Academics/Depts/IGSD/About/unique.html>>.

Zientek, Mark. Telephone interview. Nov.-Dec. 2005.

Appendix A: CPSC History

Headquartered in Bethesda, Maryland, the U.S. Consumer Product Safety Commission is focused on “increasing product safety and reducing public hazards” (Testimony of the Honorable Hal Stratton, Pg. 1). Created in 1972, the CPSC “is a bipartisan, independent agency charged with protecting the public from unreasonable risks of serious injury or death from more than 15,000 types of consumer products under the agency’s jurisdiction. Deaths, injuries and property damage from consumer product incidents cost the nation more than \$700 billion annually. Since its inception, the CPSC has delivered critical safety benefits to America’s families and has made a significant contribution to the 30% decline in the rate of deaths and injuries related to hazardous consumer products. (Testimony of the Honorable Hal Stratton, Pg. 1)” Headed by three presidential-nominated commissioners, the organization has many important groups reporting to it including the Congressional Affairs, Inspector General, General Counsel, Equal Employment and Minority Enterprise, the Secretary, and the Executive Director.

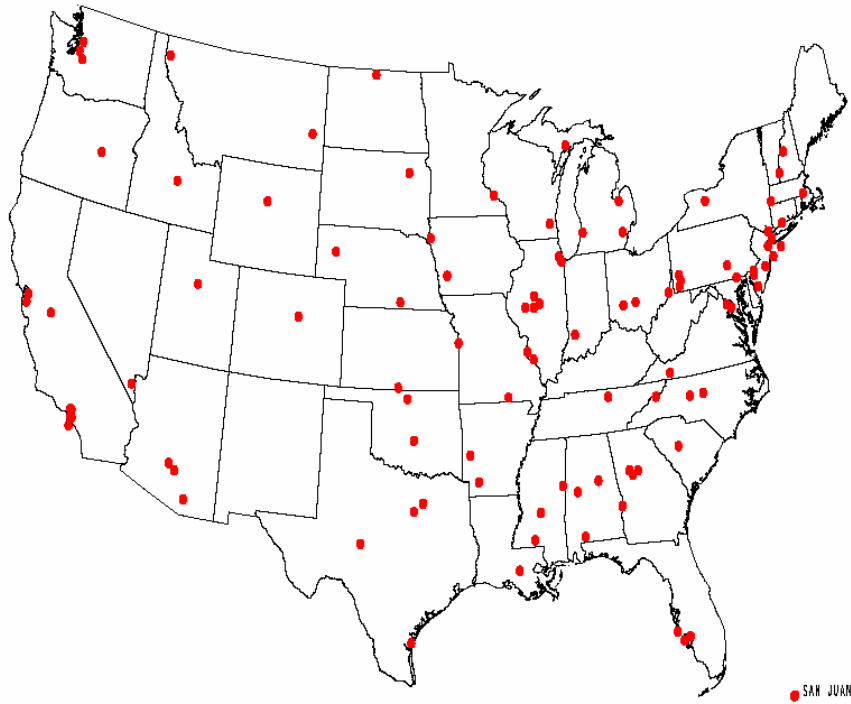
With an employee base of approximately 400, the organization has a small staff with a big mission. Although the CPSC does not give its seal of approval to products and is not charged with testing all products, it does investigate death and injuries related to consumer products. The organization’s main purpose is disseminating information to the public about the potential safety issues with a product, and occasionally has to announce recalls and/or recommend policy changes regarding potentially hazardous products. When recalls occur, the CPSC relays this information to the public as quickly as possible. They also inform the public when safer alternatives or modifications become available.

The CPSC is constantly investigating new and potential problems. One of the

ways the CPSC uses to keep current with all of the new products in the market is by enlisting the help of Worcester Polytechnic Institute. For the last 17 years the CPSC has sponsored an Interactive Qualification Project (IQP) at WPI. As a part of this project students investigate a product or group of products under the guidance of the CPSC. Over the years WPI has aided the CPSC in the investigation of everything from power tools to swimming pools to identify problems, potential problems, and resolutions or policy changes to improve public safety. With an astronomical number of consumer products on the market, it is key that the CPSC operates the way they do so that they can continue informing the public and thus saving lives.

Appendix B: Map of Hospitals Reporting to NEISS

U.S. Consumer Product Safety Commission NEISS Hospitals
2003



<http://www.cpsc.gov/neiss/2001d023.pdf>

Appendix C: Table: Monthly Breakdown of Injuries for Inflatable

Rides from 1997 to 2001

Table 10: Estimates of Non-Occupational, Inflatable Ride Injuries by Month 1997-2001.

<u>Month</u>	<u>Total</u>	<u>% Total</u>
January	369	4
February	37	0
March	1,177	14
April	771	9
May	826	10
June	987	12
July	865	10
August	1,290	15
September	793	9
October	656	8
November	335	4
December	460	5
<u>Total</u>	<u>8,566</u>	<u>100</u>

Source: U.S. Consumer Product Safety Commission, NEISS. The estimates may not sum to the totals due to rounding.

(CPSC Report, 2002 Pg.1)

Appendix D: Table: Breakdown of Injuries for Inflatable Rides from 1997 to 2001 by Age and Gender

Table 11: Estimates of Non-Occupational, Inflatable Ride Injuries by Age 1997-2001.

Age	Total	% Total
0 to 4	2,087	24
5 to 14	4,994	58
15 to 24	1,237	14
25 to 44	229	3
45 to 64	18	0
65 and Up	0	0
Total	8,566	100

Source: U.S. Consumer Product Safety Commission, NEISS. The estimates may not sum to the totals due to rounding.

Table 12: Estimates of Non-Occupational Inflatable Ride Injuries by Sex, 1997-2001.

Sex	Total	% Total
Female	4,181	49
Male	4,384	51
Total	8,566	100

Source: U.S. Consumer Product Safety Commission, NEISS. The estimates may not sum to the totals due to rounding.

Appendix E: Table: Breakdown of Injuries for Inflatable Rides from 1997 to 2001 by Body Part and Diagnosis

Table 13: Estimates of Non-Occupational Inflatable Ride Injuries by Body Part, 1997-2001.

Body Part	Total	% Total
Eye	6	0
Head/Face/Ear	1,752	20
Leg/Foot	2,496	29
Shoulder/Arm/Hand	2,925	34
Trunk/Neck/Pubic	1,363	16
> 25% Body	24	0
Total	8,566	100

Source: U.S. Consumer Product Safety Commission, NEISS. The estimates may not sum to the totals due to rounding.

Table 14: Estimates of Non-Occupational Inflatable Ride Injuries by Diagnosis, 1997-2001.

Diagnosis	Total	% Total
Concussion	47	1
Contusion/Abrasion	2,024	24
Dental Injury	29	0
Fracture	2,005	23
Hematoma	90	1
Internal Organ	585	7
Laceration	511	6
Strain/Sprain	2,224	26
Other	1,045	12
Not Specified	6	0
Total	8,566	100

Source: U.S. Consumer Product Safety Commission, NEISS. The estimates may not sum to the totals due to rounding.

(CPSC Report, 2002 Pg.17)

**Appendix F: Table: Breakdown of Injuries for Inflatable Rides from
1997 to 2001 by Disposition**

Table 15: Estimates of Non-Occupational Inflatable Ride Injuries by Disposition
1997-2001.

Disposition	Total	% Total
Treated/Released	8,153	95
Held/Observation	17	0
Hospitalized	301	4
Not Recorded	94	1
Total	8,566	100

Source: U.S. Consumer Product Safety Commission, NEISS. The estimates may not sum to the totals due to rounding.

(CPSC Report, 2002 Pg.18)

Appendix G: Survey: Manufacturers

Dear Sir or Madame,

I am a Worcester Polytechnic Institute student who is currently researching a project on inflatable amusement devices, and would like to ask you a few questions. For the purpose of this project, my project group is defining inflatable rides as an amusement inflated by a continuously running blower or fan. I have attached a brief survey that would really help me in the gathering of information for my project. It would be greatly appreciated if you could fill it out and return it to me, either via email or snail mail.

I can be contacted at jen@wpi.edu or at

Jen Hosker
4330 East West Hwy
Bethesda, MD 20814

Again, thank you very much for your time. Your help is greatly appreciated.

Sincerely,

Jennifer Hosker
Manufacturing Engineering
Worcester Polytechnic Institute

Survey

What types of inflatable amusement devices do you sell? (*Circle all that apply*).

Bounce Houses

Obstacle Courses

Inflatable Water Amusements

Other (*please specify*) _____

Slides

Inflatable Rock Walls

Interactive Games

What ride(s) have the largest sales? (*Circle all that apply*).

Bounce Houses
Obstacle Courses
Inflatable Water Amusements
Other (*please specify*) _____

Slides
Inflatable Rock Walls
Interactive Games

Is there any specific testing (both design and product) that is performed on the rides prior to sale?

Yes No

If so, please explain the types of testing that are performed.

How is maximum capacity determined?

Are directions/instructions provided to buyers at time of sale?

Yes No

If so, what is contained in these directions/instructions?

Would it be possible for you to send us a set of instructions from one of your products?

Yes No

Do your products carry warning labels of any type?

Yes

No

If so, what information is listed on these warning labels?

Is there an industry standard for these labels?

Yes

No

Which, if any, ISO certifications do you hold?

What industry standards are you in compliance with?

Are the motors/blowers you sell UL certified?

Yes

No

Do your blowers contain Ground Fault Circuit Interrupters?

Yes

No

What is the length, in feet, of the power cord on your blowers?

Do buyers often provide feedback?

Yes

No

If so, what about? *(Circle all that apply).*

Durability
Safety
Other_____

Instructions
Cosmetic

Are you part of any trade organization?

Yes

No

If so, which one(s)?

Appendix H: Survey: Rental Companies

Dear Sir or Madame,

I am a Worcester Polytechnic Institute student who is currently researching a project on inflatable amusement devices, and would like to ask you a few questions. For the purpose of this project, my project group is defining inflatable rides as an amusement inflated by a continuously running blower or fan. I have attached a brief survey that would really help me in the gathering of information for my project. It would be greatly appreciated if you could fill it out and return it to me, either via email or snail mail.

I can be contacted at jen@wpi.edu or at

Jen Hosker
4330 East West Hwy
Bethesda, MD 20814

Again, thank you very much for your time. Your help is greatly appreciated.

Sincerely,

Jennifer Hosker
Manufacturing Engineering
Worcester Polytechnic Institute

Survey

What types of inflatable amusement devices do you rent? (*Circle all that apply*).

Bounce Houses	Slides
Obstacle Courses	Inflatable Rock Walls
Inflatable Water Amusements	Interactive Games
Other (<i>please specify</i>) _____	

Which rides account for the greatest number of rentals? (*Circle all that apply*).

Bounce Houses
Obstacle Courses
Inflatable Water Amusements
Other (*please specify*) _____

Slides
Inflatable Rock Walls
Interactive Games

When people rent from your company, who is in charge of setting up the ride? (*Circle all that apply*).

Operator
Customer
Other (*please specify*) _____

Delivery Driver

Does your company provide operators for the amusement rides?

Yes

No

If so, please describe the training they are given.

What determines if an operator needs to be present at the ride?

Company policy
Specific Ride
Other (*please specify*) _____

Size of event
Weather Conditions

Are you part of any trade organization?

Yes

No

If so, which one(s)?

Appendix I: Survey: State Officials

Dear Sir or Madame,

I am a Worcester Polytechnic Institute student who is currently researching a project on inflatable amusement devices, and would like to ask you a few questions. For the purpose of this project, my project group is defining inflatable rides as an amusement inflated by a continuously running blower or fan. I have attached a brief survey that would really help me in the gathering of information for my project. It would be greatly appreciated if you could fill it out and return it to me, either via email or snail mail.

I can be contacted at jen@wpi.edu or at

Jen Hosker
4330 East West Hwy
Bethesda, MD 20814

Again, thank you very much for your time. Your help is greatly appreciated.

Sincerely,

Jennifer Hosker
Manufacturing Engineering
Worcester Polytechnic Institute

Survey

What types of rides are in your jurisdiction?

Bounce Houses	Slides
Obstacle Courses	Inflatable Rock Walls
Inflatable Water Amusements	Interactive Games
Other (<i>please specify</i>) _____	

When are rides inspected in your jurisdiction? (*Circle all that apply*).

After set period of time

After an accident

After a complaint

All new inflatables

Randomly

Other (*please specify*) _____

If rides are inspected at preset time intervals, what are these intervals?

What do you look for when inspecting inflatable rides?

In your experience, what do you think the major causes of injuries related to inflatable rides are?

Misuse

Poor Supervision

Faulty rides

Rough-housing

Other (*please specify*) _____

Which causes of injuries, in your opinion, are the most preventable? (Please explain.)

What type of training is necessary to become an inspector?

Is there anyone else who you think could assist me in this project?

Appendix J: Survey: Trade Associations

Dear Sir or Madame,

I am a Worcester Polytechnic Institute student who is currently researching a project on inflatable amusement devices, and would like to ask you a few questions. For the purpose of this project, my project group is defining inflatable rides as an amusement inflated by a continuously running blower or fan. I have attached a brief survey that would really help me in the gathering of information for my project. It would be greatly appreciated if you could fill it out and return it to me, either via email or snail mail.

I can be contacted at jen@wpi.edu or at

Jen Hosker
4330 East West Hwy
Bethesda, MD 20814

Again, thank you very much for your time. Your help is greatly appreciated.

Sincerely,

Jennifer Hosker
Manufacturing Engineering
Worcester Polytechnic Institute

Survey

Are there any prerequisites for membership?

Yes

No

If so, what are they?

What are the specific benefits of membership?

Do you set standards for your members?

Yes

No

If so, what are they?

Do you collect incident/injury data from your members?

Yes

No

Do you collect any usage statistics, such as number sold, number rented?

Yes

No

If so would it be possible to include these numbers here?

How does this data compare to that of non-members?

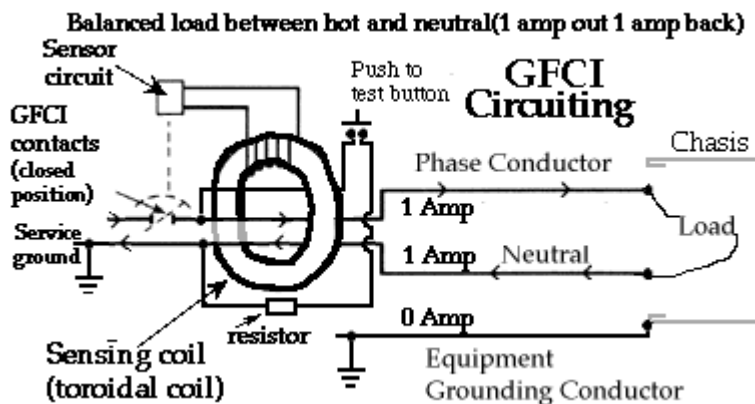
Appendix K: GFCI Information

G.F.C.I. by [Sam Goldwasser](#)

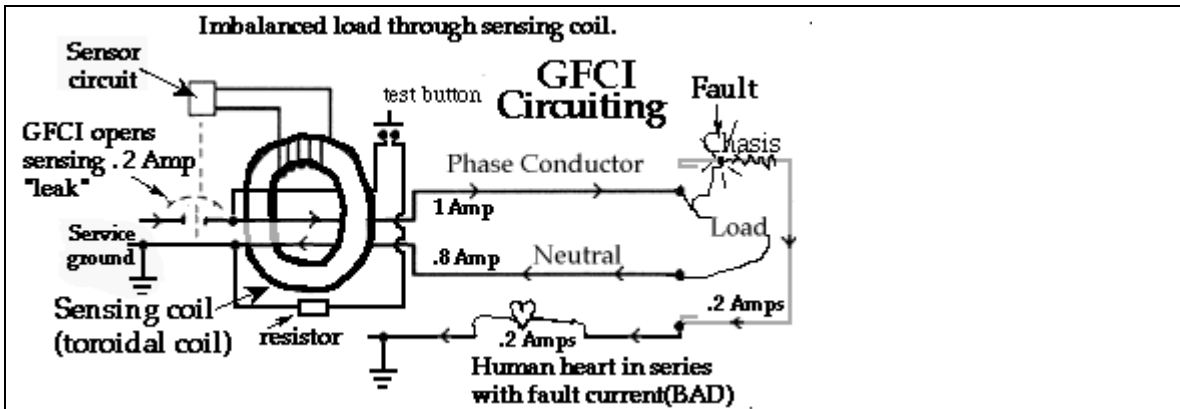
-- excerpts from: Sci.Electronics.Repair FAQ:<http://www.repairfaq.org/>

What is a GFCI?:

A Ground Fault Circuit Interrupter (GFCI) is a device to protect against electric shock should someone come in contact with a live (Hot) wire and a path to ground which would result in a current through his/her body. The GFCI operates by sensing the difference between the currents in the Hot and Neutral conductors. Under normal conditions, these should be equal. However, if someone touches the Hot and a Ground such as a plumbing fixture or they are standing in water, these currents will not be equal as the path is to Ground - a ground fault - and not to the Neutral. This might occur if a short circuit developed inside an ungrounded appliance or if someone was working on a live circuit and accidentally touched a live wire.



The GFCI will trip in a fraction of a second at currents (a few mA) well below those that are considered dangerous. Note that a GFCI is NOT a substitute for a fuse or circuit breaker as these devices are still required to protect equipment and property from overloads or short circuits that can result in fire or other damage.



GFCIs can be installed in place of ordinary outlets in which case they protect that outlet as well as any downstream from it. There are also GFCIs that install in the main service panel.

Note that it may be safe and legal to install a GFCI rated at 15 A on a 20 A circuit since it will have a 20 A feed-through. Of course, the GFCI outlet itself can then only be used for appliances rated 15 A or less.

Many (if not most) GFCIs also test for a grounded neutral condition where a low resistance path exists downstream between the N and G conductors. If such a situation exists, the GFCI will trip immediately when power is applied even with nothing connected to the protected outlets.

How does a GFCI work:

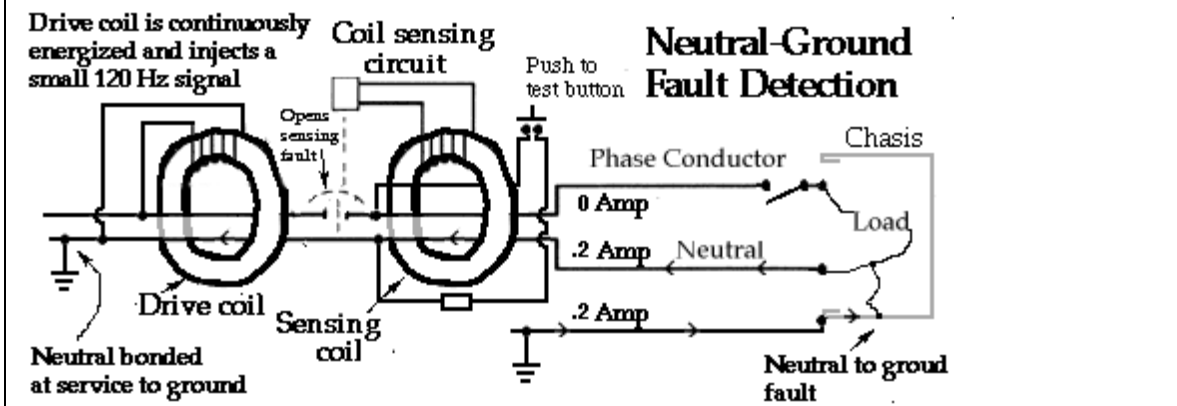
GFCIs typically test for the following condition:

- A **Hot to Ground** (safety/earth) fault. Current flows from the Hot wire to Ground bypassing the Neutral. This is the test that is most critical for safety.
- A **Grounded Neutral** fault. Due to miswiring or a short circuit, the N and G wires are connected by a low resistance path downstream of the GFCI. In this case, the GFCI will trip as soon as power is applied even if nothing is connected to its protected (load) circuit.

To detect a Hot to Ground fault, both current carrying wires pass through the core of a sense coil (transformer). When the currents are equal and opposite, there is no output from its multiturn sense voltage winding. When an imbalance occurs, an output signal is

produced. When this exceeds a threshold, a circuit breaker inside the GFCI is tripped.

To detect a Neutral to Ground fault there is a second transformer (left toroid in the [illustration below](#)) placed upstream of the H-G sense transformer (in the [illustration above](#)). A small drive signal is injected via the 200 T winding which induces equal voltages on the H and N wires passing through its core.



- If N and G are separate downstream (as they should be), no current will flow in either wire and the GFCI will not trip. (No current will flow in the H wire as a result of this stimulus because the voltage induced on both H and N is equal and cancels.)
- If there is a N-G short downstream, a current will flow through the N wire, to the G wire via the short, and back to the N wire via the normal connection at the service panel. Since there will be NO similar current in the H wire, this represents a current unbalance and will trip the GFCI in the same manner as the usual H-G short.
- If there is a H-H

[Incidentally, a type A GFCI will detect a "hotted hot" <G> as well as a grounded neutral. If there is a parallel path path from the load side hot back to line side hot, it will trip via the same mechanism as the load grounded neutral trip. So, a GFCI won't work on a "double ended" circuit.

It works pretty simply when you study that circuit you pointed us to to. The second coil has as its primary the unfiltered output of the full-wave rectifier. If a closed loop condition exists between any of the two wires going through the coil, this will induce a ~120Hz current in that closed loop. Ingenious!... "Richard G. Jones"

<publius@_greenville.infi.net_>1997/08/23]

(http://www.codecheck.com/gfci_principal.htm, 11/25/05)

Appendix L: UL Listing Correspondence

From: Daniel.C.Mordini@us.ul.com [mailto:Daniel.C.Mordini@us.ul.com]

Sent: Wednesday, November 02, 2005 4:05 PM

To: Shibilialia, David

Subject: Re: FW: Fan Blowers for Amusement Park Rides for Kids Etc

Hi Dave,

There is a whole lot more to this than I thought. We will no longer cover blowers for amusement rides for kids - i.e. "bounce type" rides. The primary engineer tells me that although the restriction is not specifically in the previous (currently effective) paragraphs, we began applying the restriction over a year ago. We reviewed all of the fan files and added instructions to our factory inspection staff telling them that there must be no reference to this use of the Listed blowers anywhere on the product, in the instructions, or in literature associated with the blowers. The CPSC states that these products must comply with 16CFR Part 1505. Based upon the actions we have taken, I suspect that there are issues in that CFR that are not addressed in UL507. Thus we applied the restriction already. At this point, we will not List products specifically for this use.

All this does not mean that a producer of the amusement ride won't use a Listed blower, but such use is beyond the scope of the UL Listing.

Regards,

Dan

DAN MORDINI

Sr. Staff Engineer

Retail Marketing

Underwriters Laboratories Inc.

(847) 664-2180 direct

(847) 313-2180 direct PC fax

"Shibilia, David" David.Shibilia@fciconnect.com
