MIFACE INVESTIGATION: #03MI022

SUBJECT: Indoor amusement manager killed when struck by a moving roller coaster

Summary

Figure 1. Derailed roller coaster

On March 1, 2003, a 43-year old male amusement manager of an indoor restaurant and game room facility was killed when he was struck from behind by a moving 5-car roller coaster. The victim entered the fenced roller coaster area near the end of the ride circuit. The ride operator had completely loaded the cars and the ride was approximately half way through one track circuit. It is thought that he was looking at a structural area previously identified by a building inspector as needing a support plate on the floor. The roller coaster operator did not see the victim enter the area or see the coaster strike the victim. When the roller coaster came around the track curve, it either struck him or a piece of the front roller coaster car caught on a piece of his clothing and dragged him on the track. (See Figure 1).The coaster ran over the back of the victim's neck and derailed. 911 was called and emergency response arrived. The victim was declared dead at the scene.

RECOMMENDATIONS

- Ensure that lockout/tagout procedures are followed when servicing machines and equipment.
- Provide lockout/tagout training to employees to ensure that the purpose and function of the energy control program is understood.
- Prohibit employee entry into a ride operation area while the ride is in motion.
- Place warning signs at the back entrance of the ride area prohibiting entry via this entrance unless the ride is locked/tagged out.
- Position mirrors within a ride area to eliminate "blind spots" for the ride operator.

INTRODUCTION

On March 1, 2003 a 43-year old male amusement manager was killed when he was struck from behind by a moving roller coaster. On March 3, 2003, MIFACE investigators were informed by the Michigan Occupational Safety and Health Act (MIOSHA) personnel who had received a report on their 24 hour-a-day hotline that a work-related fatal injury had occurred on March 1, 2003. On March 27, 2003 the MIFACE researcher visited the indoor restaurant and game room, spoke with the manager, and viewed the incident site. During the course of writing the report, the death certificate, autopsy results, police report and the MIOSHA citations were obtained. All figures in this report were photos from the MIOSHA report file.

The company received 3 alleged serious citations that all related to the Control of Hazardous Energy sources, Part 85. These citations were that the company did not develop, document and utilize procedures for the control of potentially hazardous energy when employees are engaged in service or maintenance of machines or equipment where unexpected energization, start-up or release of stored energy could occur and cause injury (the coaster was not locked out and the employee was struck by the lead car of the roller coaster while checking a section of the track), there was no training for authorized employees on the recognition of applicable hazardous energy sources, the type and magnitude of the energy available in the workplace, and the methods and means necessary for energy isolation and control, and that training was not provided for affected employees on the purpose and use of the energy control procedure.

This franchise has been in business for approximately 10 years and has franchises located within Michigan and the U.S. The franchise has been at the same location for approximately 7 years. The company has a variety of indoor attractions, such as roller coasters and other mechanical rides, games, and a restaurant/snack area. The victim was a salaried, full-time employee, and had been employed with the company for 7 months. He was the amusement park manager. His responsibilities included maintenance and repair of all equipment (rides, games, etc.) used at the facility. He was also responsible for safety talks with other employees. The victim had 20+ years experience in machine maintenance and repair.

The company did not have a written health and safety program or a health and safety committee; the company had a written health and safety policy statement that gave a general overview of the company's safety philosophy, but few specifics for MIOSHA-required programs. All employees go through a new hire orientation that included a safety orientation. The safety orientation involved safe ride operation and passenger safety; employees must read and provide a signature indicating that they have read and understand all company policies, including the health and safety policy. The company had a ride operator training checklist that must be completed and signed and dated by the manager and crewmember, certifying that the individual understands how the ride operates and how to ensure the safety of passengers and what to do in case of emergency. All new hires were required to successfully complete a quiz concerning company policies and procedures. The ride operators were trained using the standard operating procedures detailed in the equipment operator's manual. The company had a permit to operate the roller coaster. The ride had previously passed inspection in 2002 by a Michigan Carnival Amusement act inspector

Ride operators are trained to run the coaster through three complete circuits, and then stop the coaster, and let the passengers disembark. The company has a safety meeting at least once per month.

INVESTIGATION

The company leases this 5-car roller coaster from the manufacturer. The coaster is designated as a free-fall coaster. The coaster is pulled up the lift hill (the first hill), using a chain wound around gears at both the top of the hill and bottom of the lift hill. (See Figure 2) A motor powers the chain loop and it turns the loop of chain so that the coaster can be raised up the lift hill. The chain is grabbed by 2 sturdy hinged hooks (chain dogs) under the track at the bottom of the lift hill. When the ride starts, the motor powers the chain and the chain/chain dogs pull the cars up the lift hill. At the top of the hill, the chain dogs are released and the roller coaster begins its descent down the hill. Once at the top of the lift hill, the coaster travels by its own power along the tracks and cannot be stopped until the coaster enters the chain area again, where brakes can be applied, and the chain dogs hook onto the chain. The chain area begins before the operator's position. An emergency stop is present and was functional at the time of the researchers visit.

Figure 2. First Hill of Roller Coaster

The lead car of the roller coaster has a "python" head design; the other 4 cars follow that theme. The roller coaster runs along a 2-inch dual rail track. The track width is 28 inches, with 24 inches between the rails. At the point where it is believed that the victim was hit by the car, the track was 18 inches off of the floor. The python head is approximately 30 inches tall. The coaster's speed is approximately 10-12 miles per hour, or approximately 24-28 feet per second. The ride circuit begins at the operator station where passengers are seated and secured in the coaster cars. A track circuit begins and ends at the operator's station. The normal ride is three times around the track circuit. (See Figure 3)

Figure 3. Overview of Ride

The area the roller coaster operates within is fenced and has only one entrance/exit location for passengers, which is controlled by the ride operator. Within the ride area, there is scenery in support of the coaster theme to add to the enjoyment of the ride.

Two maintenance issues had been addressed by the company prior to the fatality. A few days prior to the fatality, the victim performed repair on the clutch to operate the coaster so it would tow the cars up the first hill. Two weeks prior to the incident, a city building inspector inspected the facility and notified the facility owner that he had to install a metal support plate on the floor to stabilize the roller coaster track. The plate the company had ordered to be installed was a ¼ inch steel plate, 12 inches wide and 40 inches long.

On the day of the incident, the company manager stated that the company was running a normal operation. The company had a morning meeting requiring all employees to attend. At this meeting, the victim as well as the company manager reinforced company policies and procedures.

The victim entered the ride area while the ride was running without the knowledge of the ride operator. The ride operator was at the operator station. It is believed that the victim entered through the tunnel area from the back portion of the ride. When the MIFACE researcher stood at the operator's control panel, the location where the victim was struck is hidden by a plant decoration.

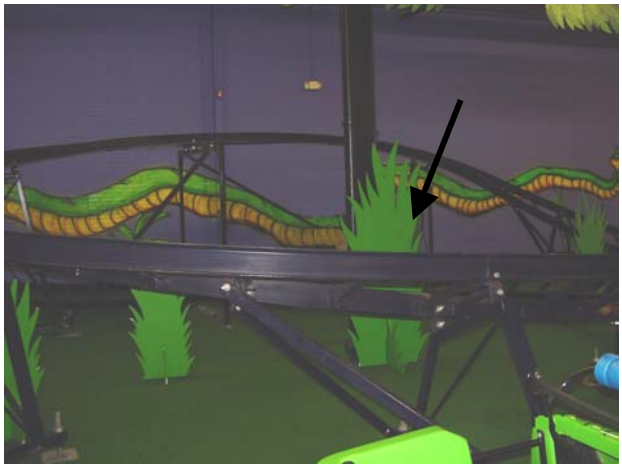

Figure 4. Approximate Location of Victim

It is unknown if the ride operator stopped the coaster at the end of the 3rd circuit, or if the operator let the coaster continue around the track for a 4th time. Patrons on the ride witnessed the death. The location where the victim was stuck was at a descent from a hill that curves toward the tunnel area. This location is also the location where the building inspectors indicated the track required the metal floor support plate. Witness statements do not concur concerning the location of the victim. It is thought that the victim was inside of the tracks when he was struck, but he may have been standing along side of the track. It is unknown if the victim was facing toward the approaching coaster or if his back was facing the coaster. As the roller coaster came to the position of the victim, the "Python" head on the first car of the roller coaster either struck the victim or caught on a piece of his clothing. A part of the victim's pant leg near the cuff was ripped. The victim was struck from behind by the first car in the right neck/shoulder area. The victim was run over by the car and dragged approximately 5 feet before the car derailed. The right front wheel assembly of the first car derailed after breaking a 6 inch section of track. The victim's screwdriver was on the floor near the track and a type of screw identical to those found on the roller coaster was found near his shoe.

The ride operator heard the "crash", then left the operator area and went to see what was wrong. He saw the victim under the coaster, and as trained, went to the manager of the facility. The manager and other employees escorted the passengers on the coaster off of the coaster into a

waiting area. Company employees lifted the car off of the victim. When the owner arrived at the scene, he stated the victim was lying on his back with the car on top of him.

State inspectors for the carnival and amusement division did not find any mechanical problems with the roller coaster that would play a role in this fatality. In fact, they stated that a metal plate was not required due to the design of the coaster.

CAUSE OF DEATH

The cause of death as listed by the medical examiner on the death certificate was death by multiple injuries. Toxicological results were negative.

RECOMMENDATIONS/DISCUSSION

- Ensure that lockout/tagout procedures are followed when servicing machines and equipment.

It is thought that the victim was inspecting the section of track where the floor plate was required by the building inspector. Lockout/tagout of the roller coaster's energy source prior to entry into the operating space would have prevented the incident. MIOSHA General Industry Safety Standard, Part 85, The Control of Hazardous Energy Sources defines servicing and/or maintenance as "workplace activities such as constructing, installing, setting up, adjusting, inspecting, modifying and maintaining and/or servicing machines or equipment. These activities include lubrication, cleaning or unjamming of machines or equipment and making adjustments or tool changes, where the employee may be exposed to the unexpected energization or startup of the equipment or release of hazardous energy." The coaster service manual included the method for locking/tagging out the machine. Energy control devices (locks) were available, but not used by the victim.

- Provide lockout/tagout training to employees to ensure that the purpose and function of the energy control program is understood.

Part 85 requires that employers establish a written energy control program that includes energy control procedures, employee training and periodic inspections to ensure compliance with the program. The victim was considered the "authorized" employee, the person who locks out or tags out machines or equipment in order to perform servicing or maintenance on that machine or equipment. Any ride attendant would be considered an "affected" employee, an employee whose job requires him/her to operator or use a machine or equipment on which servicing or maintenance is being performed under lockout or tagout, or whose job requires him/her to work in an area in which such servicing or maintenance is being performed. Part 85 defines the training requirements for authorized and affected employees.

- Prohibit employee entry into a ride operation area while the ride is in motion.

Based on witness statements, the victim was in the ride operation area while the coaster was in motion. It is unknown if the coaster was on the 3rd or 4th time around the circuit. Although the ride is noisy and can be easily heard when it is operating, the victim may not have been listening for it if he thought that the last circuit had been completed. The victim was able to enter the ride area unseen by the ride operator due to the configuration of the coaster track design. Employees, other than the coaster attendant standing at the operator station, should be strictly prohibited from entering the area of coaster movement.

- Place warning signs at the back entrance of the ride area prohibiting entry via this entrance unless the ride is locked/tagged out.

Engineering controls are an employer's first choice to prevent employee access to hazardous or potentially hazardous areas. Since the back entrance is also used for the circuit of the ride, it is difficult to guard appropriately to allow for safe conduct of the ride and to prevent employee entrance to the operational area. To assist in alerting employees to the hazard posed by entering this area while the ride is in motion and to reinforce the prohibition of entering the area when the ride is not locked/tagged out, a warning sign should be used. The American National Standards Institutes Z535 standards were revised in 2002. ANSI Z535 standards describe the proper format and content of safety signs and labels. ANSI Z535 series of standards were first published in 1991, revised in 1998 and in 2002. The 2002 revision of ANSI Z535 contains two parts that are very relevant to safety signs, ANSI Z535.3 Criteria for Safety Symbols and Z535.2 Environmental and Facility Safety Sign Standard. An employer's use of an American National Standard is voluntary.

The safety sign contains three sections, the signal word, the symbol panel (optional) and the message panel. The signal word indicates the level or degree of hazard - Danger, Warning or Caution. "DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situation. WARNING indicates a potentially hazardous situation, which, if not avoided, could result in death or serious injury. CAUTION indicates a potentially hazardous situation, which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices." The format of the sign also includes a safety alert symbol, a triangle with an exclamation mark appearing to the lift of the signal word.

The revised standard also accommodates symbols. A symbol may only be used to substitute for a portion or all of a word message if it has been demonstrated to be satisfactorily comprehended (e.g. Annex B of ANSI Z535.3) or there is a means (e.g. instructions, training materials, manuals, etc.) to inform people of the symbol's meaning. With proper employee instruction, an advantage of a symbol or pictorial is that it can communicate a safety message across language barriers.

The message panel should use as little text as possible to clearly convey the message, be explicit (tell the reader exactly what to do or not to do), use short, familiar words and use the active voice.

MIOSHA General Industry Safety Standard Part 37, Accident Prevention Signs and Tags, Rule 3706 states that employers shall provide, install and maintain signs and tags as prescribed by this part where an employee might be or would be likely to be injured if not alerted to the hazard. The MIOSHA standard require that safety signs comply with an earlier version of the ANSI safety color code (Z53.1-1971). If an employer uses safety signs complying with requirements of the ANSI Z535-2002 standards, the employer will be in compliance with MIOSHA Part 37 requirements.

The warning sign should be placed at each entrance point to the ride operation area.

- Position mirrors within a ride area to eliminate "blind spots" for the ride operator.

Mirrors positioned strategically in the ride area would help to eliminate blind spots in the ride area for the operator. The blind spots created by the use of decorations used to enhance the ride experience are unavoidable. The ride operator is responsible for ensuring the ride is operated safely; mirrors would allow the operator to have a view of the ride areas that he/she can't see from the operator's station.

REFERENCES

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   Internet site: www.howstuffworks.com/roller-coaster.htm
2. Developing Effective Warnings for the Workplace. Cheatham, D., Shaver, E., Wogalter, M. Occupational Health and Safety, 5151 Beltline Road, 10th floor, Dallas, TX 75254. Copyright 2003. Article may be downloaded from the Internet at: www.ohsonline.com
3. MDCIS, MIOSHA General Industry Safety Standard, Part 37, Accident Prevention Signs and Tags.
4. MDCIS, MIOSHA General Industry Safety Standard, Part 85, The Control of Hazardous Energy Sources
5. American National Standards Institute (ANSI), ANSI Z535 Series. Contains ANSI Z535.1 Safety Color Code, ANSI Z535.2 Environmental and Facility Safety Signs, ANSI Z535.3 Criteria for Safety Symbols, 25 West 43rd Street, 4th Floor, New York, NY 10036

MIOSHA Standards cited in this report can be directly accessed from the Consumer and Industry Services, MIOSHA website www.michigan.gov/mioshastandards.

The Standards can also be obtained for a fee by writing to the following address: Department of Consumer and Industry Services, MIOSHA Standards Division, P.O. Box 30643, Lansing, MI 48909-8143. MIOSHA phone number is (517) 322-1845.

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