Incident Summary #II-1588204-2023 (#37431) (FINAL)

SUPPORTING INFORMATION	Incident Date		August 3, 2023
	Location		Lower Mainland North
	Regulated industry sector		Amusement Devices - Zip line
	Impact – Injury	Qty injuries	1
		Injury description	A blunt force trauma injury to a zipline rider's left leg resulting in severe bleeding.
		Injury rating	Major
	Impact – Damage	Damage description	Physical damage to a metal rolling staircase including a bent rail and stairs.
		Damage rating	Moderate
	Incident rating		Major
	Incident overview		A rider on a zipline struck a metal rolling staircase used to lower riders to the ground at the landing platform.
INVESTIGATION CONCLUSIONS	Site, system and components		**Zipline** • The facility consists of four ziplines that all run with tandem parallel lines so two riders can ride at the same time in parallel with each other. • Riders meet at basecamp, go through a safety briefing and demonstration, then take a 15-minute off-road ride to the first zipline. • Portions of the four ziplines travel over 300 meters above the ground, some are over one kilometer long and riders can reach speeds up to 100 kilometers per hour (kph). • Riders are required to be six years of age or older and must be between 60-250 lbs (27-113 kgs). • The incident occurred on the third zipline in the tour. It is the shortest and steepest line with an average gradient of 14% and brings guests up to 100-kph and back to zero in less than 30 seconds depending on rider and environmental conditions. • When riders travel down the zipline, they are secured in a harness that is attached to a trolley with wheels that travels along the zipline cable. The trolley does not have any mechanical ability to slow or stop the decent of the rider. • When riders enter the landing stations, the trolleys contact a primary stop cart that is attached by a rope to a series of pullies and springs that absorb the energy and bring the riders to a stop. **New guide training** • New guides must complete zipline training before guiding guests without the supervision of a training guide. • Training consists of 4-5 days of a training course that covers all the stages of being a guide. • They must write a written exam with a minimum score of 80% to pass. • They must complete a minimum of 3 shadow tours where they work as a guide while being evaluated by a team lead.

- They must complete a signoff tour with evaluation and final sign off by a team lead.

Zipline tour guides

- Each zipline tour has a minimum of two guides, one for launching the riders from the launching platforms and one for receiving the riders at the landing platforms.
- The guides are trained for both launching and landing and alternate the launching and landing of riders for the tours.
- Tours over ten guests could have an extra guide added to the tour to assist the receiving guide to help keep the tour on time.

Six-point check

- A six-point check is conducted on both the riders and on the braking systems before each launch. The receiving guide does a visual check on the braking system and the launching guide does a visual and physical check on the riders and equipment.
- Confirmation of the proper storage/placement of the staircases, out of the rider's zipline path, were not part of the six-point check.

Radio communication

- The safety protocol is made up of radio communications and six-point checks at the launch and landing. Handheld radios are used to communicate the status of the braking system and the guests.
- Radio communication is the tool that links the guides together. The ziplines are large distances apart and the guides are unable to visually see what's happening on the opposite platforms.
- The receiving guide initiates the radio protocol with the launching guide, after the receiving guide gets a response, they perform the six-point check and inform the launching guide the brakes are reset. The launching guide performs a six-point check and informs the receiving guide that riders are clipped and adjusted. The receiving guide performs the six-point check, then informs the launching guide it is safe to send the riders by stating "10-4 fly". The launching guide then removes the safety tethers from the guests and launches them down the line.
- Variations of the radio protocol are used to accommodate for different situations such as single riders, lines closed for maintenance, and guides self-launching.
- The radio protocol did not specifically address the proper storage/placement of the rolling metal staircases, out of the rider's zipline path, on the third zipline.

Codes and standards

CSA (Canadian Standards Association) Z267-00 "*Safety code for amusement rides and devices.*"

- The CSA Z267-00 "*Safety code for amusement rides and devices.*" Is the adopted code in British Columbia for amusement rides, including ziplines, at the time of the zipline's design and major alterations.
- The code identifies in clause 5.3.3 that passenger clearance shall be designed to minimize the opportunity for contact between a passenger and

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	any object where said contact is likely to cause injury during operation of a ride or device. ASTM (American Society for Testing and Materials) F2959-23a "*Standard Practice for Aerial Adventure Courses"* • The ASTM F2959-23a is not an adopted standard in British Columbia but is considered a recognized document with additional information to be considered at the time of zipline system design or major alteration. • The ASTM standard includes under design requirements, that general design criteria shall include the designer/engineer to perform and document analysis that illustrates how hazards to persons have been managed and shall include a "*Patron Clearance Envelope Analysis.*" • A patron clearance envelope analysis is conducted to minimize the opportunity for contact between the patron and other objects where said contact is likely to cause injury. • The analysis shall include that any moveable system or device designed to temporarily encroach on the patron clearance envelope (including loading / unloading platforms) shall be designed in a fail-safe manner in order to prevent unintended contact.
Failure scenario(s)	In 2016 the zipline received a major upgrade to the braking system and landing deck. The braking system was upgraded to an automatic resetting system to address the high maintenance demand and slow resetting time of the previous manual resetting system. The new system required extending the landing platform to unload riders', far enough away from the edge of the platform. The platform extension involved lowering of the platform to provide a level working area. The lowering of the platform left the riders higher from the deck surface then previous and required a change from the original three step aluminum ladder to a larger moveable steel staircase with a handrail. The documents for the braking system and platform changes were reviewed and stamped by a professional engineer. There was no evidence identified during the investigation that a patron clearance envelope analysis was completed for the addition of the rolling metal staircases, which encroached on the patron clearance envelope, and to ensure that the system was designed in a fail-safe manner in order to prevent unintended contact. The receiving guide during the incident was a new employee, and had fully completed guide training, tour shadowing, and received a sign off by a team lead for guiding without supervision. The guide had received a total of approximately 40 individual guests at the landing platform of the zipline prior to the incident and was on their third day working as an unsupervised guide. The day of the incident was busy, and the two guides had previously completed two tours of 12 guests and were on their third tour of 10 guests. The first tour started at 9:15 AM and the third tour started at 3:30 PM. Only the two guides were responsible for guiding the groups and no third guide was added for any of the larger groups that day. When the first two tours of the day completed, the guides only had approximately 15-minutes to complete their equipment checks before the next tours began. The guides had minimal time for any work breaks since the start of the day. On the day of the incident, the third zipline group of the day, which consisted of ten guests and two guides, started the zipline tour of four ziplines. On the third zipline, the launching guide sent three sets of riders down to the receiving guide. When the riders landed at the bottom platform, the receiving guide used the two rolling metal

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	staircases to dismount the riders from the elevated line. After the third set of riders dismounted the lines, the receiving guide only returned the riders right-side rolling staircase to the dedicated safe parked position but did not return the staircase on the left-side line. The guide completed the required six-point check, reset the brakes, and interacted with the landed guests which included: instructing two guests to place their helmets back on which they had removed, informing another guest of a safe location to film upcoming guests, and answering questions from another guest regarding the details of what was being done when resetting the braking systems. The receiving guide completed the radio protocol with the launching guide and sent the message "10-4 to fly" to the launching guide while the staircase was still in the left-side rider's path. The launching guide then sent the next two riders down the ziplines. The six-point check and radio protocol for the third zipline did not include checks or references to the rolling staircase positions. As the riders were both approaching the landing platform, the rider on the left-side and the receiving guide realised the rolling staircase was in the path. The guide did not have time to move the staircase out of the way and the rider did not have any ability to slow or stop their descent. The staircase did not have any protective padding or covering, and the rider struck the staircase railing with the side of their leg at an estimated speed of 60-80 km/hr. The collision pushed the staircase up the wooden platform, bent the metal staircase structure and caused a major blunt force trauma injury and severe bleeding to the rider's leg. Emergency first aid procedures were administered to the injured rider, and they were transported to hospital for treatment.
Facts and evidence	Receiving guide statements • They had completed their weeklong training on May 15th, then came back in July and completed seven shadow shifts. Each one being more involved ending with a sign off by a team lead that allows them to guide unsupervised. • The day of the incident was their third day working as an unsupervised guide after completing training and sign off. • Typical procedure is: 1. Riders will come in and land at the brake. 2. Guides will then pull the staircase and lock it into position and the rider will maneuver themselves onto the staircase and climb up a couple of steps to get their harness lanyard unclipped from the trolley. 3. Riders then walk down the steps down to the ground. 4. Guides then take the trolley off and give it to the rider. 5. Guides then unlock the staircase and put the staircase back into the safe stored position. 6. Then the procedure is repeated for the other rider. • They do not recall any deviation from the process on that run. It was the same process from when they started from training as what was done on that day. The right-side was put in and they believed they would have followed the same procedure and put the left-side in, but they do not recall if that was done. • It had been 8 hours of work from about 9:00 AM - 5:30 PM without taking a break. They would have taken a break if it was possible during the shift, but it was too busy, and they had felt "tired and drained" at the time of the incident. • With smaller tours, there are abilities to stop and take breaks. Tours are given three hours. The first tour of 12 took about two hours and 45-minutes to complete. They went out at 9:30 AM and came back at 12:15 PM which gave the guides 15-minutes until the next tour started. In that time the gear

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needed to be checked again, brought to the vehicles, and they needed to travel back to the top to start again.
- The second tour was the same with only 15-minutes to check gear.
- The six-point checks are the same on ziplines one and two but on the third zipline there is an “unspoken seventh-point check” to ensure the stairs are in the correct place and all the way in the proper storage/placement position before sending riders down.
- They could not recall ever seeing a staircase on that zipline roll out of the stored location on their own.

Launching guide statements

- The staircases are stored in small storage areas and don’t protrude past the landing platform handrails. When riders come in and come to a stop, the staircases are pulled out and brought up to the riders. They then take the trolley off the line and pass it to the riders, then push the staircase back in and push the locking bar down on the bottom to lock the staircase in place.
- They use both staircases. First, they pull one out, then put it back then go do the other staircase, then put it back. If procedures are followed correctly, then no staircases should be left out.
- When the zipline brakes are reset, they check to make sure the brakes are in good condition and the staircases are put away.
- When working as a receiving guide, they stand on the pad between the lines. After the launching guide says the riders were clipped in and adjusted, they perform one more visual check, then say “10-4 fly” which tells the launching guide it is ok to send the riders.
- They prefer to stand ahead of the staircases, but some guides prefer to stand on the upper platform to look bigger and get the attention of the riders because the third zipline is their fastest line and it is important to get the riders into their landing position so they can land safely.
- Distractions are always a factor. This is the most exciting zipline and riders tend to want to talk to the guides after they finish the ride.

Witness (Rider) statements

- On the third zipline, they were the first ones to go down. There was one guide on the launching side and one guide on the receiving side.
- There were metal stairs needed to get the riders off the ziplines. After the third pair of riders came down the line, the left-side staircase was not put back to its proper placement.
- They saw the guide not put the left staircase away, then the guide went over to the other side to help the guest and then put that staircase away.
- Instead of putting the staircase back, the guide walked over and unharnessed the next rider, gave them the harness, then walked to the back to adjust the springs for the braking systems. The guide then radioed to the launching guide the brake call, then was seen talking to guests at the back where the brakes were and then they saw the next riders coming down.
- Leading up to the incident, the receiving guide seemed energetic, knowledgeable, professional, aware, and cognizant of what was going on. They did not witness any indications of safety concerns with the guide’s actions.
- The guide was on the elevated deck when the fourth set of riders came down and the guide had been in the areas of the staircases.
- Without a doubt, the staircase was all the way out of the slot. The guide never revisited the staircase once they walked across to help the other guests.

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Guide training manual

- The guiding ratio is 10 guests per each guiding pair. Tours over 10 guests *can* have an extra guide to keep the tour on time.
- A typical day is comprised of three tours with up to four tours a day during peak season.
- The third zipline is shorter but very steep with an average gradient of 14% bringing guests up to 100km/hr and back to zero in less than 30-seconds.
- With 10 guests and two guides, it takes around 25-minutes to complete each line and a tour takes approximately just under three hours.
- Investigative review of the manual determined that there is no inclusion of safe use or confirmation of positioning of the staircases for the third zipline included in the training manual or radio protocol.

Zipline #3 testing data sheet (July 2022)

- Testing conducted with a variety of guides and weights identified a top recorded rider speed of 82kph and an average landing speed of 58.8kph with the environmental conditions and rider positioning.
- The heaviest test weight used was approximately 30lbs less than the weight of the injured rider during the incident which suggests the rider may have been traveling at an even higher rate of speed than those recorded during the tests.

Summary

The redesign of the landing platform in 2016 added rolling metal staircases to unload riders. No evidence was found during the investigation that an analysis was conducted to identify new hazards and potential sources and consequences of harm with the change, and the system was not designed in a fail-safe manner in order to prevent unintended contact.

A guide with completed training but limited experience was guiding guests on a busy day. The day started at 9:15 AM and there was very limited time available for work breaks due to guest volume and guest/guide ratio. Approximately eight hours after the workday started, the guide was receiving guests at a tandem zipline. The guide completed the six-point checks and radio protocol that is in the written training guide. The guide admitted feeling “very tired” and experienced multiple potential distractions that occurred involving guest/guide interactions. The guide did not notice that one of the two staircases was not put away and sent the all clear “10-4 fly” message to the launching guide.

The six-point check, radio protocol and training manual did not include a process for confirming the safe location of the staircases prior to sending riders on the third zipline. There was no fixed system design to identify or alert if the staircases were not in their safe dedicated storage locations or to physically prevent a rider from being sent if a staircase was in a rider’s path. The launching guide is unable to see the status of the landing platform from the launching platform and solely relies on the receiving guide to confirm that conditions are safe to launch guests. Once riders are launched there is no mechanical ability for the rider to slow or stop their descent. There is no guidance or procedure to control where the receiving guides stand, and it is left to the discretion of the guide where to situate themselves on the platform when assessing that the conditions are safe for launching guests and receiving launched guests.

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Causes and contributing factors	The cause of the incident was the staircase being left out when the clear to fly call was given. Likely contributing factors to the incident include: • The official six-point check, radio protocol, and guide training materials did not include confirmation of safe staircase positioning. • The guest volume, guest/guide ratio, and limited time for employee work breaks increased the risk of human errors with the guides. • Reliance on one human-centric point of safety to ensure the staircases are secured in a safe position before an all-clear signal is sent to the launching guide. • The design of the major alteration in 2016, which included the staircase that increased risk of injury to the riders, did not include risk mitigations or a fail-safe system to prevent unintended contact between riders and the staircases which encroached on the patron clearance envelope.

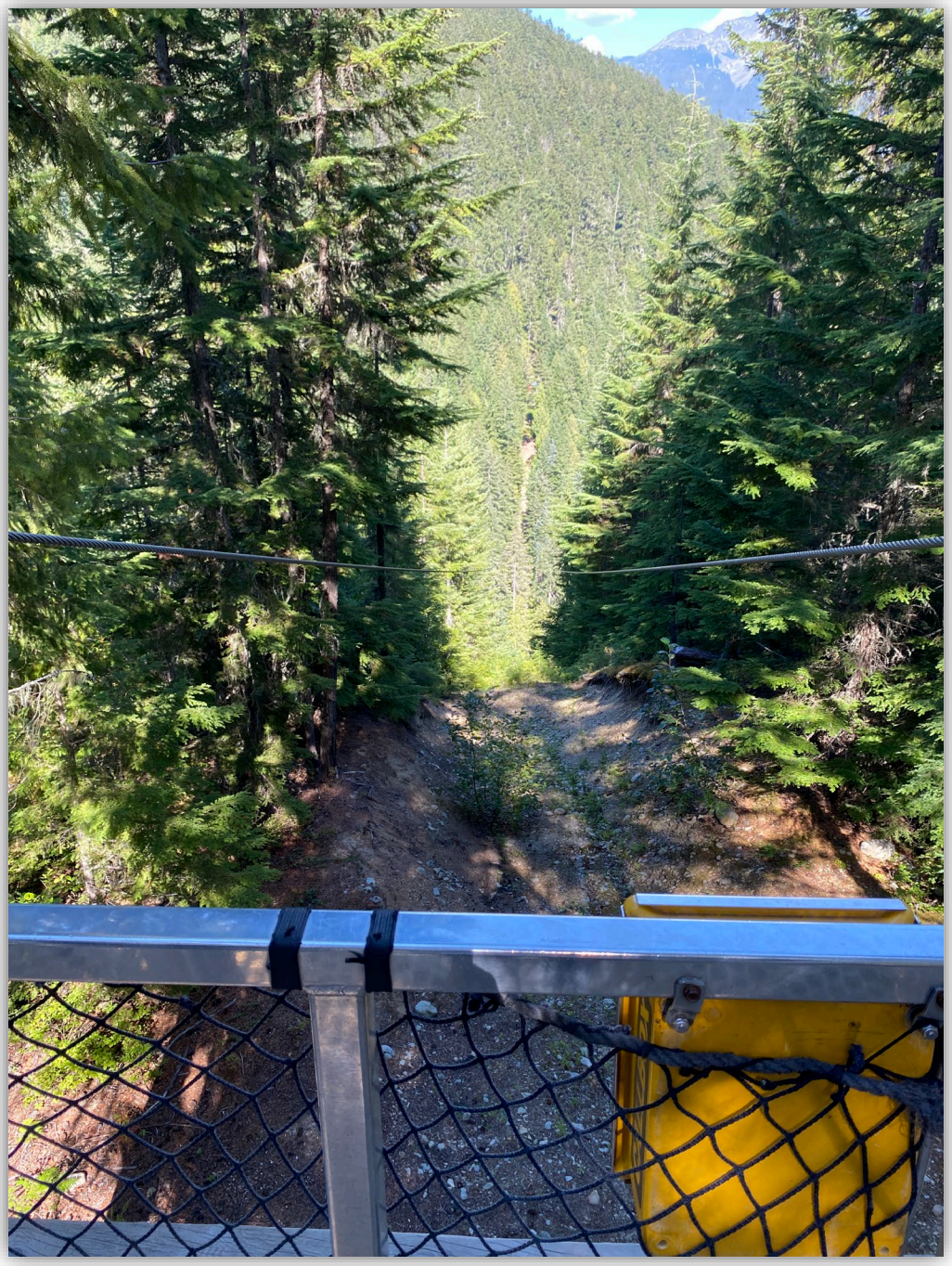

Image 1 – View from launching platform of the third zipline showing parallel tandem ziplines.

Image 2 – Sign showing proper rider's landing position.

Image 3 – View of the third zipline from below.

Image 4 – The third zipline's landing platform. [**RED**] Blue rolling staircase in the safe stored location on the rider's right side.

Image 5 – Third zipline landing platform showing braking mechanism.

Image 6 – Rolling staircase placed in the stowed storage location out of the path of the riders.

Image 7 – Staircase storage location with beveled edges [**RED**] for capturing staircase wheels.

Image 8 - Landing area of the third zipline showing the rolling stairs in the location to dismount zipline riders.

Image 9 – Staircase in the location where the rider collided with it.

Image 10 - Staircase in the same location as when the rider collided with it.

Image 11 – Damaged staircase bent by the impact from the rider.