Incident Summary #II-957412-2019 (#16152) (FINAL)

SUPPORTING INFORMATION	Incident Date			December 10, 2019
	Location			Vancouver
	Regulated industry sector			Elevating devices - Elevator
	Impact	Injury	Qty injuries	0
			Injury description	No injuries
			Injury rating	None
		Damage	Damage description	Damage to elevator sling, top of elevator components and an overhead hitch beam. Elevator floor tiles damaged from impact.
			Damage rating	Moderate
	Incident rating			Moderate
	Incident overview			During an annual emergency brake test procedure known as "unintended motion" the emergency brakes failed to deploy. The car continued to ascend until it's counterweight collided with the buffer and the car struck the overhead beam.
Nd INVESTIGATION CONCLUSIONS	Site, system and components			• An electric elevator of the roped traction type. • This unit uses steel ropes, electric motor and a counterweight to raise and lower the car. • Motor has a brake assembly consisting of 2 electromagnetic brakes (automatically activated by a solenoid). • 2 brake compression springs to adjust holding force. • The electric motor, drive sheave and brakes are one unit mounted in the overhead of the hoistway. • A controller in a remote room, located in an underground parkade. • A brake board module located in the controller cabinet. • A manual for testing procedures. • Buffers- The buffer's role is to stop a descending car or counterweight beyond its normal limit of travel and to soften the force of impact during an emergency. A traction elevator works by having an electric motor raise and lower the elevator by its steel ropes. The ropes are tied to the elevator car on one end, then looped around the drive sheave of the electric motor (See photo #1). The sheave grips the ropes allowing them to rotate as the sheave spins. When the motor turns one way, the sheave raises the elevator, when the motor turns the other way it lowers the elevator. The steel ropes that lift the car are also attached to a counterweight that hangs on the other side of the drive sheave. This counterweight weighs the same as the car plus an additional 50% of the car's maximum load capacity. The purpose of the counterweight is to conserve energy by making it easier for the motor to raise and lower the car. This unit's motor is designed with two brake pads (primary and emergency) mounted on the sides of the drive sheave, and are held open by a solenoid (an electromagnet used to convert electric energy to mechanical energy). One brake pad is mounted on each side of the sheave. Under normal operation the solenoid is automatically energized when the elevator is in motion. The energized solenoid keeps both the brake pads in the open position

	(*"picked")* until the elevator has arrived at its designated level. Upon arriving at a floor level and coming to a full stop, the solenoid automatically de-energizes and both the brakes drop to clamp down on the drive sheave. This holds the elevator while the doors open. The car is held in place by the brakes until the next call is placed. For brake testing purposes a potentiometer (an adjustable variable resistor) located on the brake module board is used to adjust the voltage applied to the solenoid, which affects how much energy the solenoid has to pick the brakes. Compression springs mounted on the side of each brake pads are used to adjust the holding force of the brakes. The springs are compressed using an adjustment nut for greater holding force or decompressed for less holding force(See photo #1). Having too much compression on the spring can lead to the brakes not picking or slightly dropping as the elevator is in motion. The brakes not being fully picked while the elevator is in motion wears out the brake pads over time and may lead to brake related issues. Having too little holding force can result in the elevator not being able to hold itself in place while parked at a landing. Brake tests are required to be performed, at a minimum, annually by qualified mechanics. The emergency brake test known as "*unintended motion*" is supposed to verify that moving the car away from a landing with both car and hoistway doors open will be detected by the controller and will clamp the emergency brake and stop the car within 48 inches. This tests the emergency brake stopping and holding force as the primary brake is electrically or manually held open("*picked*") to allow for the emergency brake to do all the work . Under normal operation the controller would detect an unintended motion fault and both brakes would clamp. The test is performed twice, once with the car at its maximum load capacity plus an additional 25 percent (125%) and then again with no load in the car. Both tests require that both brakes be held open to initiate the unintended motion but that only the emergency brake deploy once the unintended motion is detected. During the 125% load test, the car travels in the down direction due to the combined weight of the car and test weights exceeding the counterweight. During the no load test, the car travels in the up direction due to the counterweight weighing more than the car. During this test the mechanic would follow the manufacturers written procedures, located on-site.
Failure scenario(s)	Testing of the emergency brake was being performed with no load in the car. Manufacturers test procedures were not followed correctly. The car was put into an unintended motion test in the up direction with the main brake being manually held open. The emergency brake failed to stop the car and the car travelled in the up direction until the counterweight struck the buffer located below it and the car struck the overhead hitch beam. .
Facts and evidence	**Photos of controller log** • Photo of the "unintended motion fault" triggered during the test (See photos #2 and #3) • Photos of mechanics initial steps captured by the fault log leading up to incident.

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Lead Mechanic's written statement

- After servicing and adjusting the compression tensioning springs on the brakes, the mechanic tested the brakes by riding the elevator on top of car and ensuring the brakes held the weight.
- The Mechanic then proceeded to set up in the control room to perform the brake test. The second mechanic set up at lobby in front of the car door.
- Lead mechanic radioed to the mechanic at lobby to stand by for test.
- Lead mechanic pushed the brake test buttons.
- The brakes didn't open and the car didn't move.
- Lead mechanic tried again, pushed the buttons but brakes failed to open.
- The lead mechanic then transferred a set of brake wires to a different set of terminals in an attempt to open the brakes. Terminals BT1 and BT2.
- Mechanic tried to open the brakes up again to drift the car but brakes failed to open.
- The lead mechanic then transferred the brake wires back to their original terminals.
- Put the brake board on manual mode again and pushed the buttons to open the brakes.
- Brakes opened up on the third attempt but the mechanic did not know.
- The emergency brake failed to stop the car drifting upwards.
- The mechanic wasn't aware the car was drifting while he still compressed the brake test buttons.
- The counterweight gained momentum as it came down and the car shot upwards.
- Car crashed into the overhead and counterweight struck the buffer(See photo #7).
- Car came to a rest after colliding with the overhead hitch beam.

Evidence observed on-site

- This controller manufacturer has a written procedure for performing the "unintended motion" test.
- The controller is located in a separate location not in close proximity to the elevator, it is not possible for the mechanics to have direct verbal communication or for the other mechanic in the control room to have a visual of the elevator. Two way radios are used to communicate back and forth.
- The controller is also equipped with an LCD screen that, when set correctly, provides the mechanic with a visual indication of car movement, direction and speed.
- Measurements for unintended motion could also be calculated from the LCD screen when set correctly.
- A brake module board, also installed in the controller, allows the mechanic to switch operation of the brake solenoid from automatic to manual. Under normal operation, the board is set to automatic and the controller provides the braking when needed.

Written manufacturer procedures with correct steps to perform unintended motion and troubleshoot brake related issues.

- For brake testing purposes, the instructions require the brake module board to be switched to manual mode, giving control of the brakes to the mechanic.
- Once the mechanic has control and is ready to perform the test, two test buttons installed in the controller cabinet open the brakes when pushed, letting the car naturally drift with gravity. The controller is programmed to detect this as an "unintended motion" fault and automatically deploys the brakes while the mechanic forces the primary brake to stay picked(open), by keeping pressure on the brake test buttons.
- Once the car has come to a complete stop, the mechanic would release the push buttons allowing the main brake to deploy. The mechanic standing on the car side at lobby would radio back to the mechanic how many inches the car travelled.
- The manufacturer for this controller recommends that a potentiometer (adjustable variable resistor) trim pot labeled R67 on the brake board be used to calibrate the brake pick voltage if the brakes fail to pick (open).

Photos from top of car and hoistway pit.

- Photo from top of car showing the overhead hitch beam the car collided with. (See photo #4.)
- Photo of car resting in the overhead and the counterweight on the pit buffer. (See photos #7,#8 and #9)

Written and signed statements of events leading up to the incident from both mechanics.

- Testing procedures from the manufacturer not followed- Lead mechanic states that after a second failed attempt he switches the brake wires to different terminals in an attempt to open the brakes.
- No visual guidance during testing - The manufacturers testing procedures fails to provide the user with instructions on how to use the LCD board to monitor movement and speed of the car.
- Mechanic unaware of the LCD board to monitor car movement and speed- The mechanic performing the test makes no mention of ever having a visual on the car during the test. Was unaware of such a feature when asked.
- No troubleshooting attempted - The lead mechanic does not recognize that there is a trim pot R67 marked on the manufacturers procedures for adjusting brake pick voltages.
- Brake down of two way radio communication – The mechanic in charge of providing feedback to the lead mechanic states that the repeated message to stop, did not go through until it was too late.
- Lack of training on equipment and interpretation of electrical prints- The mechanic was asked as part of the investigation if he checked the voltage to the brakes. The mechanic responded as not knowing how to check or how to troubleshoot the brake system using electrical drawings.

57 days after acceptance test

An acceptance test was conducted weeks after the incident . Unintended motion was performed and no issues were witnessed during the testing of both brakes. Same motor and same controller. A new

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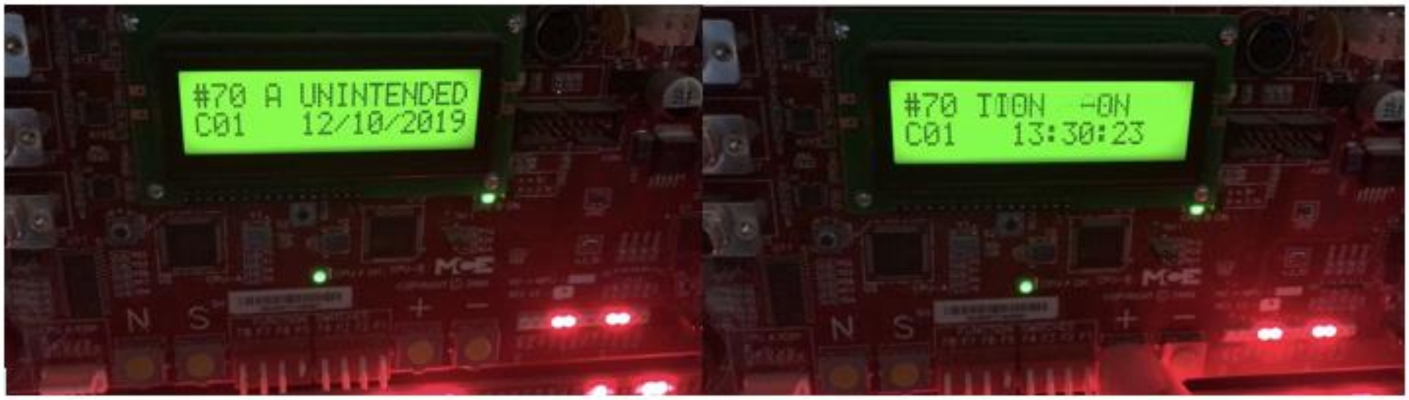
	brake pad had been installed in replacement of the original as an added precaution.
Causes and contributing factors	There are multiple variables that led to this incident. It is very likely that the failure of the emergency brakes to deploy during the "unintended motion" test was due to user error. The mechanic not utilizing the LCD to monitor the car's speed and location likely contributed to the incident. It is possible that a lack of sufficient training on the equipment at hand was a contributing factor. It is unknown if the emergency brake failed to deploy or if it deployed but failed to stop the car. It is possible that the emergency brake pad wasn't tensioned properly after being serviced earlier in the day, leading to the emergency brake not stopping the elevator. It is also possible that the mechanic not following the manufacturers testing procedures lead to the emergency brake not deploying. It is very unlikely that the controller's software had any part in the failure of the emergency brakes not deploying. The same controller and motor were tested vigorously for any faults during a follow up acceptance test and no issues were encountered.

Photos and Diagrams:

Photo #1- Overhead installation of motor and brake assembly. This pic shows the steel ropes wrapped around the drive sheave. This machine is secured to a beam located in the overhead.



Photos #2 and #3 - Fault Log Registers an Unintended Motion Condition – Emergency Brakes Should Have Deployed and Stopped the Car.

Photo # 4 - This pic from the top of the car shows the hitch beam that it came into contact with. Rollers were damaged upon impact.

Photo #5 - Damaged floor tiles from impact

Photo #6 – Damaged roller guides on top of car

Photo #7- Photo show car resting in the overhead while the counterweight rests on the buffer.

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Photo #8 – Picture of counterweight resting on buffers with slacked cables.

Photo #9 - Picture shows a compressed counterweight buffer.