Incident Summary #II-799779-2019 (#10596) (FINAL)

SUPPORTING INFORMATION	Incident Date		January 15, 2019
	Location		Whistler
	Regulated industry sector		Passenger ropeways - Above surface ropeway
	Impact – Injury	Qty injuries	0
		Injury description	Not Applicable
		Injury rating	None
	Impact – Damage	Damage description	An issue with excessive sparking of a DC electric motor. Partial blockage in the radiator of the auxiliary diesel engine. Excessive debris collected in the fuel filter of the diesel evacuation drive. (incidentally it was also determined that an piston oil ring was also cracked)
		Damage rating	Moderate
	Incident rating		Moderate
	Incident overview		Due to excessive sparking of the electric main drive motor, workers switched to a diesel auxiliary drive. After operating for a period of time the auxiliary drive began to overheat. Staff then switched to a diesel evacuation drive. The evacuation drive was not capable of running at its design speed. After a period of time, the auxiliary drive cooled down enough to allow staff to switch back to the auxiliary drive and complete the evacuation of the passengers. It took 50 minutes from the point at which the auxiliary initially overheated to when all remaining passengers were removed from the ropeway.
INVESTIGATION CONCLUSIONS	Site, system and components		The detachable grip ropeway has 3 prime movers 1. A main electric DC drive motor which is cable of running the ropeway at full speed (5 m/s) under all load conditions. • The type of DC motor used in this application utilizes a stationary electromagnetic windings (field winding) which produces a magnetic field (or magnetic flux) around another rotating electromagnetic windings (armature winding). The commutator through a set of carbon or graphite brushes provides a method of conducting current from one rotating armature winding to the next rotating armature winding. • In this type of a DC motor, brush location in orientation with the commutator is set to the magnetic neutral axis (MNA). That is an axis along which the armature conductors move parallel to the magnetic lines of flux of the main field and therefore the conductors do not cut the lines of flux. The result of ensuring the brushes are located on the MNA ensures the no electromotive force (EMF) is generated into the armature conductors and that a zero voltage difference condition exists between the commutator segments when commutation occurs. In a circumstance where the brushes are not aligned with the MNA, a condition occurs where an EMF is generated and therefore a voltage difference between commutator segments. As a result, a short

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	condition would exist which would cause sparking at brush and commutator contact point. To summarize the above, A brush holder must be set to an appropriate axis point so as to ensure sparking at the brushes is not excessive. 2. A diesel auxiliary drive engine, liquid cooled, capable of running the lift at a speed of approximately 2.95 m/s - 3 m/s. depending on the uphill load. This drive allows the ropeway to operate for passengers continuously. 3. A smaller diesel evacuation drive engine, air cooled, capable of running the ropeway at .45 m/s - .5 m/s, depending on the mass of the uphill load. Evacuation drive is utilized for evacuating passengers only (not continued operation). Slope length of ropeway is 1752 m and therefore the estimated ideal length of time for the evacuation of passengers by use of evacuation drive is between 58 - 65 minutes depending on the uphill load.
Failure scenario(s)	Multiple failures relate to this incident: • Staff deemed that as the main drive electric motor was running, excessive sparking was occurring at the motor brushes. • The Auxiliary diesel drive overheated. • The diesel evacuation drive was not capable of running at the evacuation drive rated full speed. Staff report that the evacuation drive was only capable of running the ropeway at approximately .125 m/s.
Facts and evidence	**In regards to the DC motor, reports provided by staff indicate:** • That excessive sparking was observed where the motor brushes make contact with the commutator. • Because of a risk of damaging the commutator due to sparking, staff decided to shut down the electrical motor and switch to auxiliary drive as the prime mover. • Staff discovered that the brush holder (device that sets the location of the brushes around the commutator) mounting equipment was found to have loosened (due to worn clamps) and that the brush holder had moved from its original set axis. • An electric motor specialist was brought on site by the operating contractor. Adjustment was made to the brush holder magnetic neutral axis which was reported to help but did not solve the problem completely. In the attempt to correct this issue the motor is scheduled for removal, further inspection and service at the motor specialist facility. **In regards to the auxiliary drive engine, reports provided by staff indicate:** • Auxiliary drive engine overheated during operation. • Cause of overheating was determined to be related to blockages in the engine radiator. The location of blockages were determined by the use of a non-contact

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	thermometer (cool and hot spots were identified in different locations of a radiator). **In regards to the evacuation drive engine, reports provided by staff indicate:** • Evacuation drive was capable of approximately 25% of its normal speed (.125 m/s). As stated in the site systems and components section the evacuation drive is normally capable of .45 - .5 m/s. (At .125 m/s it would take approximately 3.9 hours to evacuate the ropeway lift line) • Engine repair specialist indicated that debris was found in the fuel pump strainer. Specialist also determined that 1 of the 6 pistons oil rings was damaged. Rings on the piston were replaced, fuel filters were replaced, fuel pump fuel screen was cleaned, valves adjusted and engine was tested under load.
Causes and contributing factors	**Causes and contributing factors related to excessive sparking of the brushes of the electric motor:** • It is likely that due to the brush holder mounting equipment being worn and loose that the brush holder was allowed to move from its proper set axis. This was the primary factor that likely caused the excessive sparking. **Causes and contributing factors to the overheating of the auxiliary drive**: • Blockages in the radiator were the probable cause of the engine overheating. **Causes and contributing factors related to evacuation drive not being able to run at its rated full speed:** • Although a number of issues were identified by the engine repair specialist, it is probable that the primary cause of the engine not being able to achieve full speed was the debris found in the fuel pump strainer that was restricting the flow of fuel being provided to the engine (engine was fuel starved).