

Incident Summary #II-890649-2019 (#14784) (FINAL)

SUPPORTING INFORMATION	Incident Date	August 10, 2019	
	Location	Squamish	
	Regulated industry sector	Passenger ropeways - Above surface ropeway	
	Impact	Qty injuries	0
		Injury description	N/A
		Injury rating	N/A
	Damage	Damage description	A haul rope separated and numerous gondola cabins fell to the ground. Some were pulled along the path due to topography or the released energy from the separated haul rope. Numerous cabins were damaged beyond repair. The haul rope came off of the sheave assemblies at numerous towers and was suspended within trees at locations along the length of the gondola path.
		Damage rating	Major
Incident rating	Major		
Incident overview	At approximately [REDACTED] on August 10, 2019, overnight security personnel located in buildings at the top and bottom of the gondola each reported hearing a loud noise and shortly after 5am confirmed that gondola cabins located at the stations were on the ground with damage to the cabins and stations.		
INVESTIGATION CONCLUSIONS	Site, system and components	<p>The Sea-to-Sky Gondola runs from a the lower station next to BC highway 99 to a summit lodge overlooking Stawamus Chief Mountain and Howe Sound. The gondola runs through Stawamus Chief Provincial Park which contains numerous hiking trails open to the public. Some hiking trails pass directly under the gondola.</p> <p>From the lower station, the gondola immediately ascends from the base station (towers [REDACTED]) to the top of a rock cliff to tower [REDACTED], followed in quick succession by towers [REDACTED]. A hiking trail passes under the gondola between towers [REDACTED]. Maintenance trails also exist directly under portions of the gondola run to facilitate access to the towers. A small 1-2 foot high wooden fence guides hikers to stay on the hiking trail when passing under the gondola between towers [REDACTED].</p> <p>The gondola tower is of typical design and construction and is comprised of a concrete base secured to rock and a steel tower that supports the sheave assemblies and the haul rope. Installed ladders at the base and along the column of the tower provide access to maintenance platforms to facilitate work.</p> <p>The gondola haul rope is a 52mm nominal diameter 6x36WSR steel wire rope with a solid plastic core. The minimum breaking load documented in the original haul rope test certificate is 2126kN. The total length of wire rope is 4755 metres to which 31 gondola cabins were attached.</p>	
	Failure scenario(s)	The haul rope was cut while under tension, likely from the tower [REDACTED]. Once a sufficient number of wire strands were cut, the remaining rope segment yielded under the tension from the non-operating gondola.	

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<p>Facts and evidence</p>	<p><u>Haul Rope:</u></p> <ul style="list-style-type: none"> • The downhill portion of the haul rope was found separated (image 1). One of the separated ends of the haul rope was found downhill of [REDACTED] (image 4) near the cliff base and the other separated end was found approximately 30m uphill of [REDACTED]. • The separation did not occur near the splice or any defect in the haul rope (image 1). <ul style="list-style-type: none"> ○ Splice was found downhill of [REDACTED] on the opposite side of the separation. ○ A known damaged area on the rope being monitored was found downhill of [REDACTED] on the downhill side of the run. • Failure analysis (appendix A) concluded that the majority of the haul rope wires were substantially cut prior to complete failure of the wire rope. Many individual wires failed in tension as the cutting action progressed (image 6). As the load was redistributed, the final remaining portions of the last two (of six) wire strands became overloaded and failed in tension, resulting in full separation of the haul rope. • Materials and construction analysis (appendix A) concluded that there was no evidence that the wire haul rope was defective. • The haul rope minimum design factor is identified as 4.83. The final number of individual wires that remained prior to the final strands failing in tension overload is commensurate with the design safety margin. <p>Conclusion 1: The haul rope was deliberately cut. While being cut, remaining wires of the last two strands failed in tension overload. There were no defects with the haul rope or the design of the gondola haul rope that contributed to its separation.</p> <p><u>Towers:</u></p> <ul style="list-style-type: none"> • Towers [REDACTED] were accessible from the hiking trail via the maintenance access trails. • [REDACTED]. • Installed ladders on the tower provided access to the working platform from which the haul rope was also accessible. • There were no barriers preventing access to the tower ladders. • A gondola cabin and debris was found below tower [REDACTED] that appeared to have struck the rock face and separated from the downhill haul rope [REDACTED]. Its position and that of debris indicated the separated haul rope moved uphill past tower [REDACTED] and was therefore severed below tower [REDACTED]. • Damage to tower [REDACTED] indicated the separated haul rope moved downhill past tower [REDACTED] and was therefore severed above tower [REDACTED]. • [REDACTED] <p>Conclusion 2: The cut and separation likely occurred at [REDACTED].</p>
<p>Causes and contributing factors</p>	<p>The gondola haul rope failed as a result of being deliberately cut. The cut was likely made from [REDACTED].</p> <p>NOTE: Technical Safety BC limited its investigation scope to the cause of the technical failure of the gondola haul rope. Given the deliberate nature of the cut and the concurrent investigation by the RCMP, Technical Safety BC did not pursue further evaluation of the installation, maintenance or operation of the gondola or persons responsible for cutting the haul rope.</p>

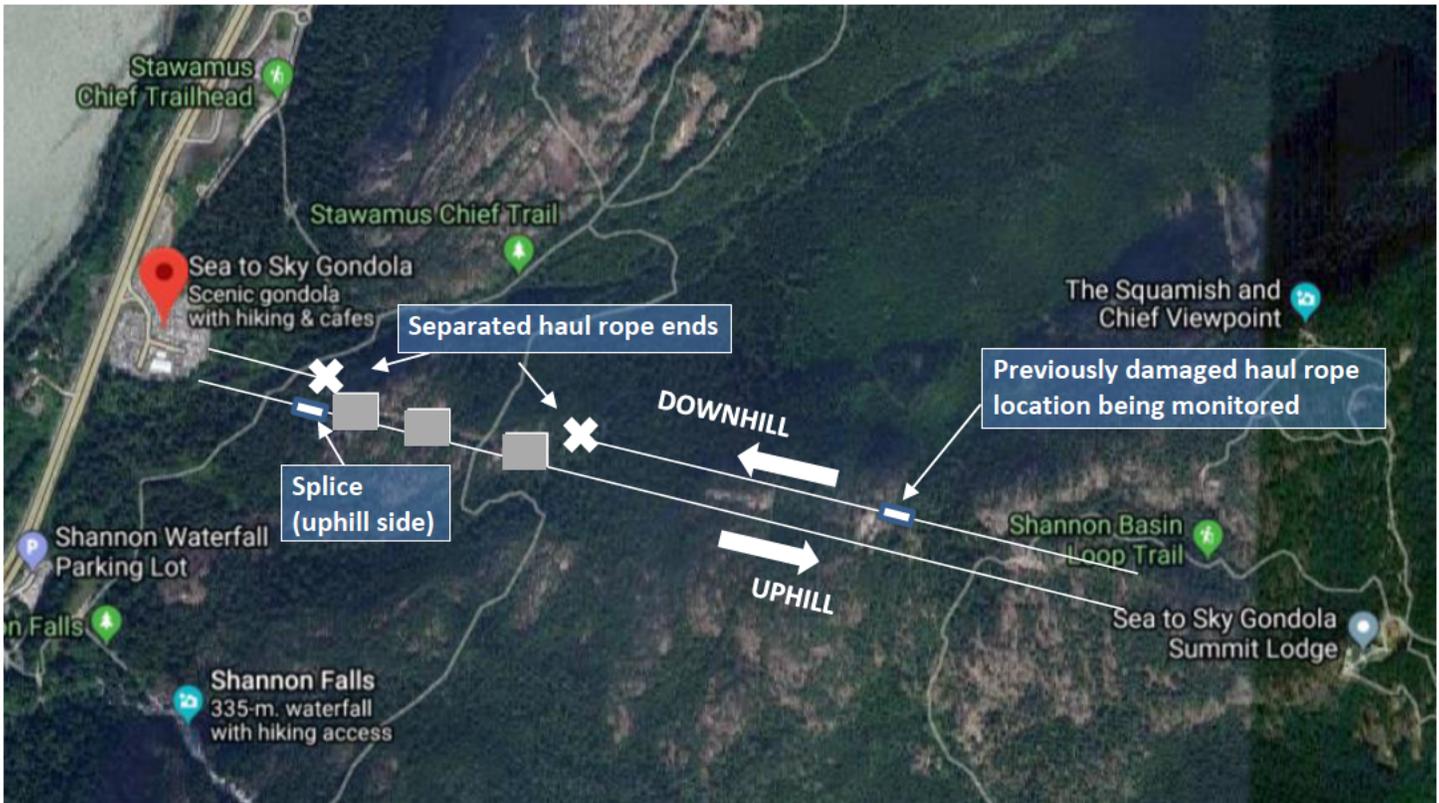


Image 1: Diagram of gondola line showing approximate locations of haul rope [redacted]. White X's illustrate the approximate locations where the separated ends of the downhill side of the haul rope were found. The splice was found downhill of tower [redacted] on the uphill side of the haul rope. A known area of previous haul rope damage that was identified for maintenance monitoring was found on the downhill side near tower [redacted]



Image 2: 

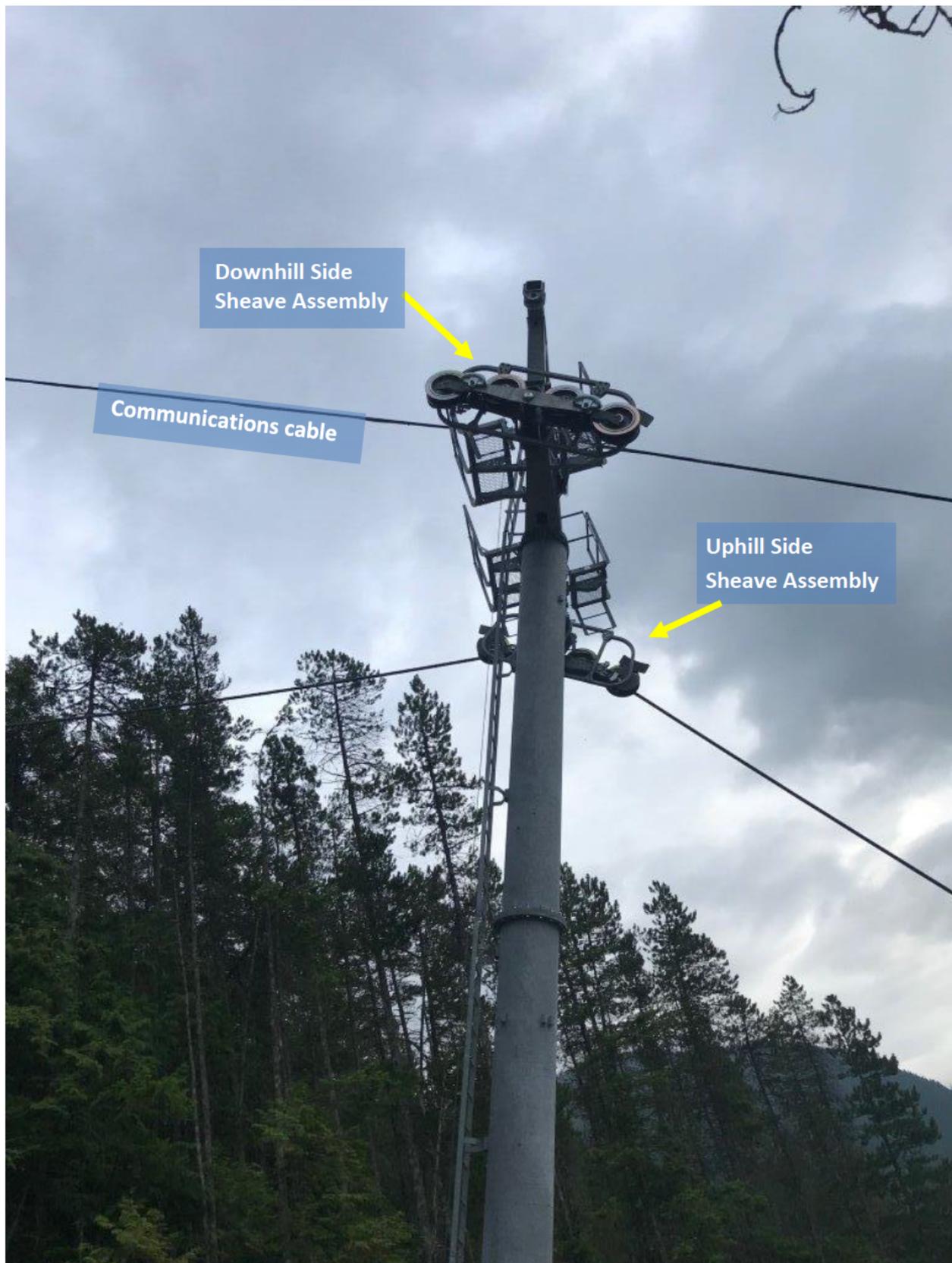



Image 3:  showing access ladder and work platforms.



Image 4: Portion of separated haul rope end found downhill of tower ■.



Image 5: View looking uphill at tower [redacted]. Damage and debris indicates gondola cabin likely struck tower/rock face after separation and haul rope was pulled out of cabin grip and past tower [redacted].

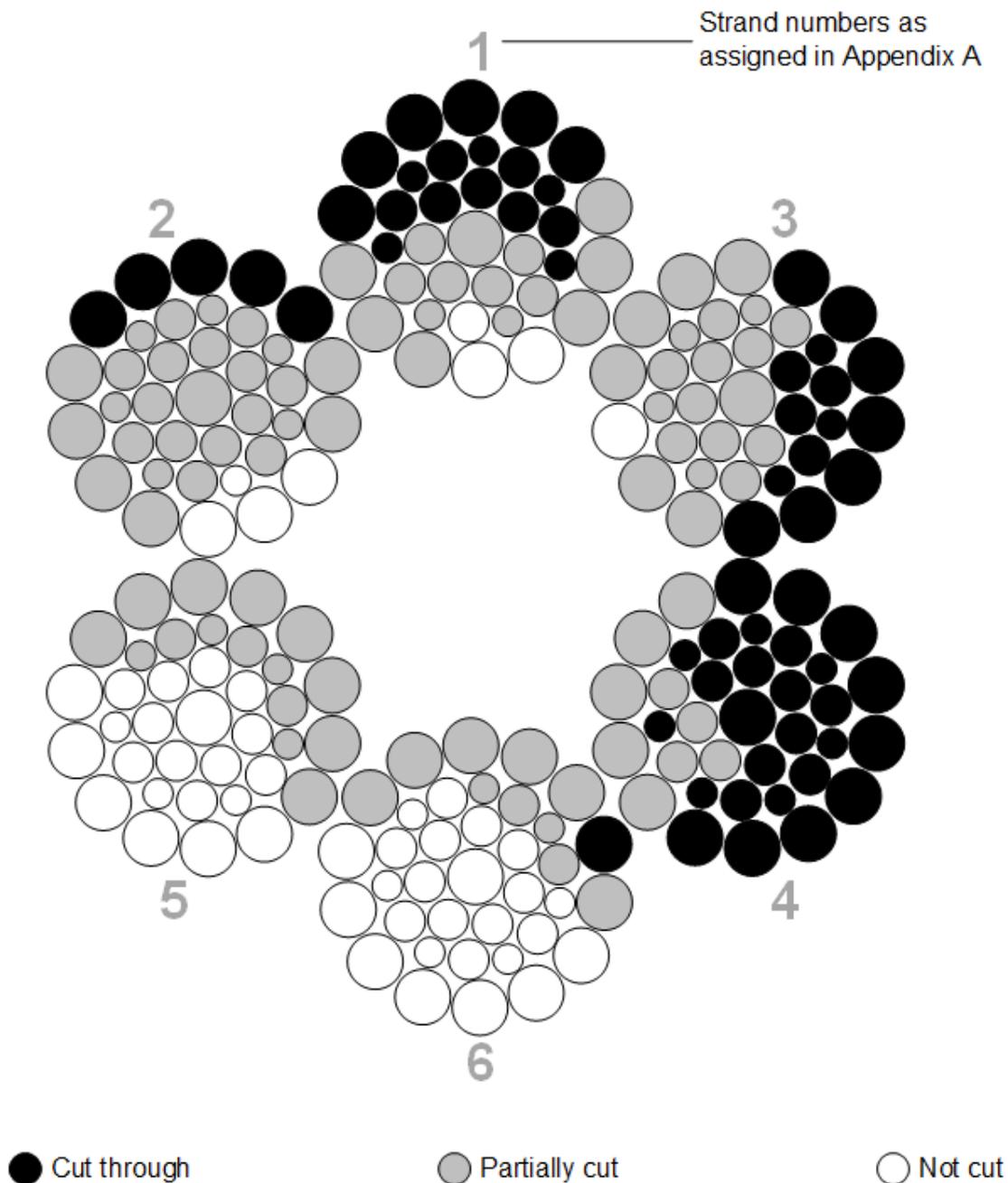


Image 6: Diagram of haul rope cross-section showing individual wire failure mode: cut-through wires, partially cut-through and tension overload (no cut). The diagram was produced to illustrate the failure methods determined and described in Appendix A: Sea-to-Sky Gondola Haul Rope Failure. The location of cut-through, partially cut or not cut wires within each strand shown is an estimate only.

Cutting was likely initiated at strands with the most number of cut-through wires. As cutting progressed, more wires failed from being either partially cut or becoming overloaded without being cut as the tension was redistributed. The last strands cut were those that failed predominantly in tension overload (not cut). Given the number of wires partially cut in these last remaining strands, it is likely that these strands failed and the haul rope separated during the cutting action.

Appendix A:
Sea-to-Sky Gondola Haul Rope Failure
ACUREN Group Inc.

Note: Technical Safety BC limited its investigation scope to the technical cause of the gondola haul rope failure. This appended report has numerous portions redacted so that its publication does not interfere with an RCMP investigation into this incident.