Incident Summary II-1678433-2024 (#44647) (Final)

SUPPORTING INFORMATION	Incident Date		February 6, 2024
	Location		Rogers Pass
	Regulated industry sector		Electrical - High voltage electrical system (greater than 1000V)
	Impact – Injury	Qty injuries	0
		Injury description	N/A
		Injury rating	None
	Impact – Damage	Damage description	A high voltage power supply and back up generator to a railway tunnel ventilation system was damaged at a fault in an underground junction.
		Damage rating	Major
	Incident rating		Major
	Incident overview		A fault in a 4160v 3-phase power cable providing power to a transformer tripped the private powerline protection providing power to the commercial railway tunnels. An emergency backup generator started and re-energized power to both tunnels following the loss of utility power, including the faulted cable. Power was then restored to all fans in the tunnel. A short time elapsed when a second fault occurred on backup power that caused damage to the generator electronic voltage regulator and de-energized the system. The resulting voltage spike damaged the separate cable feeding one (1) railway tunnel causing the fuses on phase B and C to activate.
	Site, system and components		• A private 34,500 volt 3-phase powerline originates from the local city's 25kv-34.5Kv sub-station up to a commercial railway in the mountains to supply multiple tunnel ventilation systems as well other sites for general power. The power is transformed from 34.5Kv to 4,160 volts via a 5MVA unit sub-station for local underground distribution to 2 separate 2Mva 4160volt –600-volt 3 phase services to power the ventilation systems. • The ventilation fans provide safety measures for personnel safety and safe operations by: a. Ventilating the tunnels to remove hazardous airborne products such as 'NO2' and coal dust with fresh air. b. Providing oxygen for the heavier trains to run without air starvation that could stall a heavily loaded train. • The utility power was provided with a monitoring/ protection system. • The generator was not provided with a relay monitoring/ protection system and relied solely on the overcurrent protection of the generator breaker.

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	Failure scenario(s)	An electrical fault at the junction box serving ventilation system occurred causing a trip resulting in the ventilation system losing power. The initial failure was noted in one (1) tunnel ventilation system and de-energized the utility supply to both bay's ventilation systems. The back-up generator system sensed a loss of power and started to re-energize the system ventilation fans. Then a second fault occurred during a voltage spike a short time after generator started-up which activated the fuses, causing severe damage to the junction box, the power to the site was then de-energized. Due to the second fault the generator's electronic voltage regulator (EVR) was damaged. The event monitoring log attached shows the ventilation systems in both tunnels were in operation at time of incident (Image 4).
INVESTIGATION CONCLUSIONS	Facts and evidence	• Facts gathered consisted of interviews and evidence provided by the initial electrical contractor on site and the field service representative (FSR) that was first notified of the incident and was able to view the conditions via software during the fault condition. • The tunnels are approx. 1 mile long and split into 2 sections, each fed with separate 4160 volt 3-phase feeders with 300amp fusing and a 2MVA 4160/ 600 volt 3-phase transformer operating the exhaust fans. Each tunnel consists of 6x 50HP 600volt 3-phase exhaust fans with across the line starters. • The major fault damage was noted at a 4160volt splice box with a 'Temporary' cable installed 20 years previous in Dec 2004 from a previous fault and was never replaced with a permanent solution. . • It was noted the 'faulted' cable was suitably sized to the connected load but not the overcurrent protection provided per 2004 communications. • The initial site visit from the electrical contractor noted they had to dig through deep snow to search for the fault location in which later it was found at a 4160-volt junction box below the train bridge, photos viewed were very unclear and did not provide any clear indication of fault and not included in this investigation. • A photo provided from field service representative (FSR) shows a cable hanging from the side of the bridge cable tray structure and laying on the ground which appears to be the damaged cable. It is not known if the cable previously was dislodged from its mounting strap system (noted as ty-strapped). • On initial failure of a fault in one of the tunnels 4160volt junction box the utility (private) line tripped via the over-current protection system in place de-energizing the tunnel power in both tunnels. With power loss the generator started automatically and brought power back to the tunnels with the existing initial fault still present. • The generator did not have the same protection relays in place and continued to operate, the power was able to start up all 12 fans in both bays until the condition fully faulted again, at that point the generator current spiked and the motor protection shut down, de-energizing all 12 fans. • During the second and final fault, with high current noted, the generator voltage spiked to approx. 5500volts (but likely exceeded that due to refresh rates of monitoring system), the electrical voltage regulator was unable to autocorrect quick enough and it was damaged. The power to the tunnels was fully disconnected from power and unable to operate.

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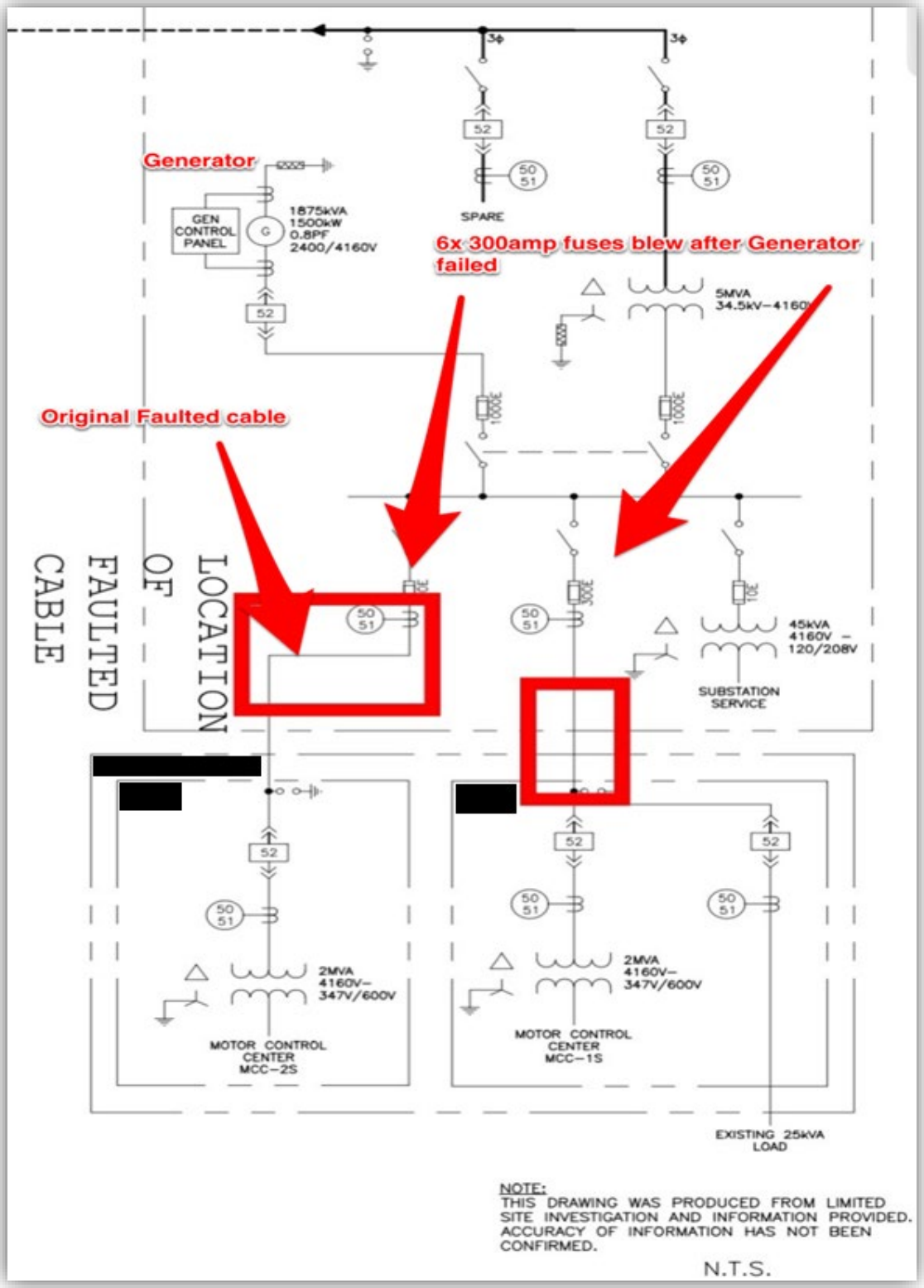
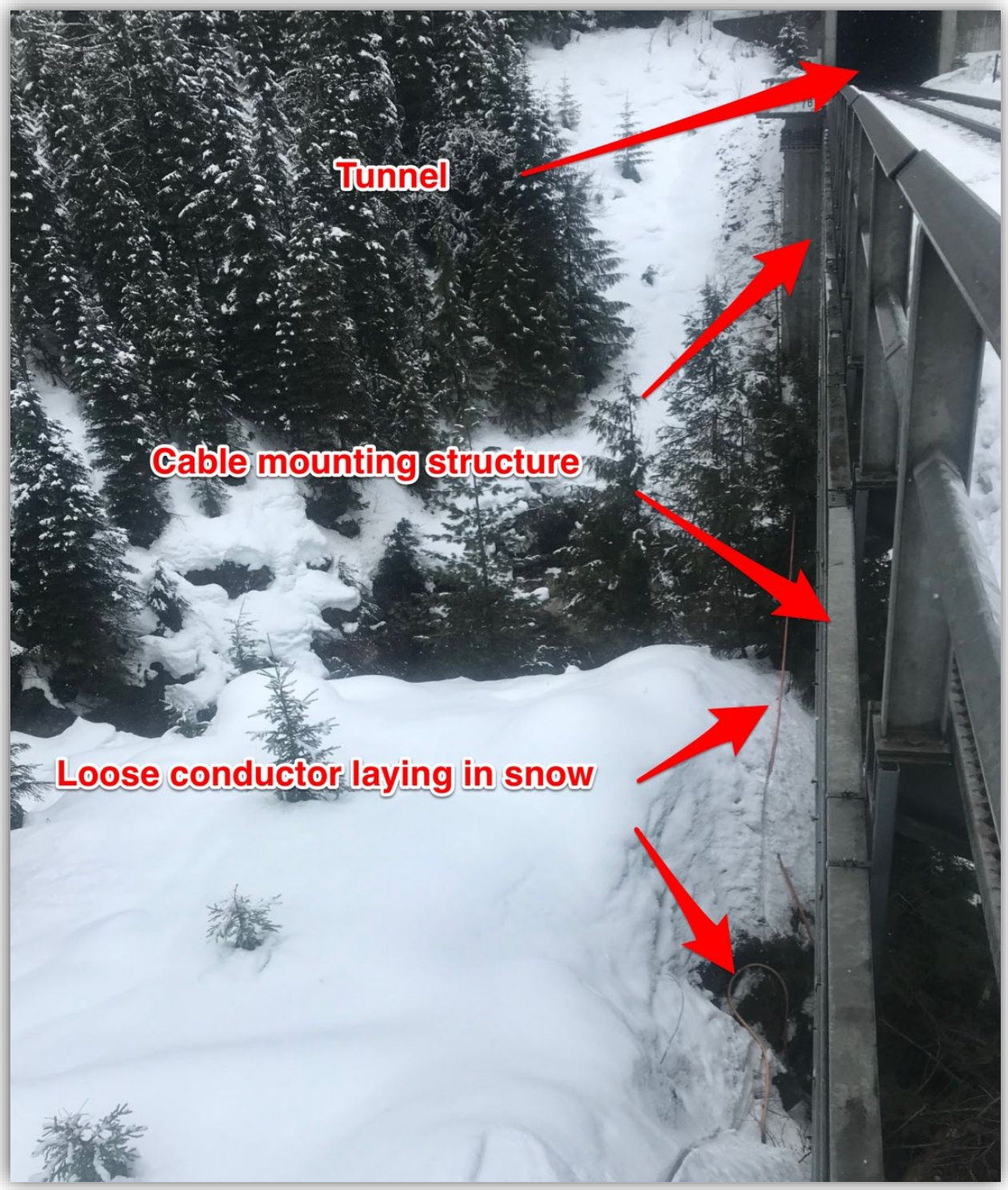
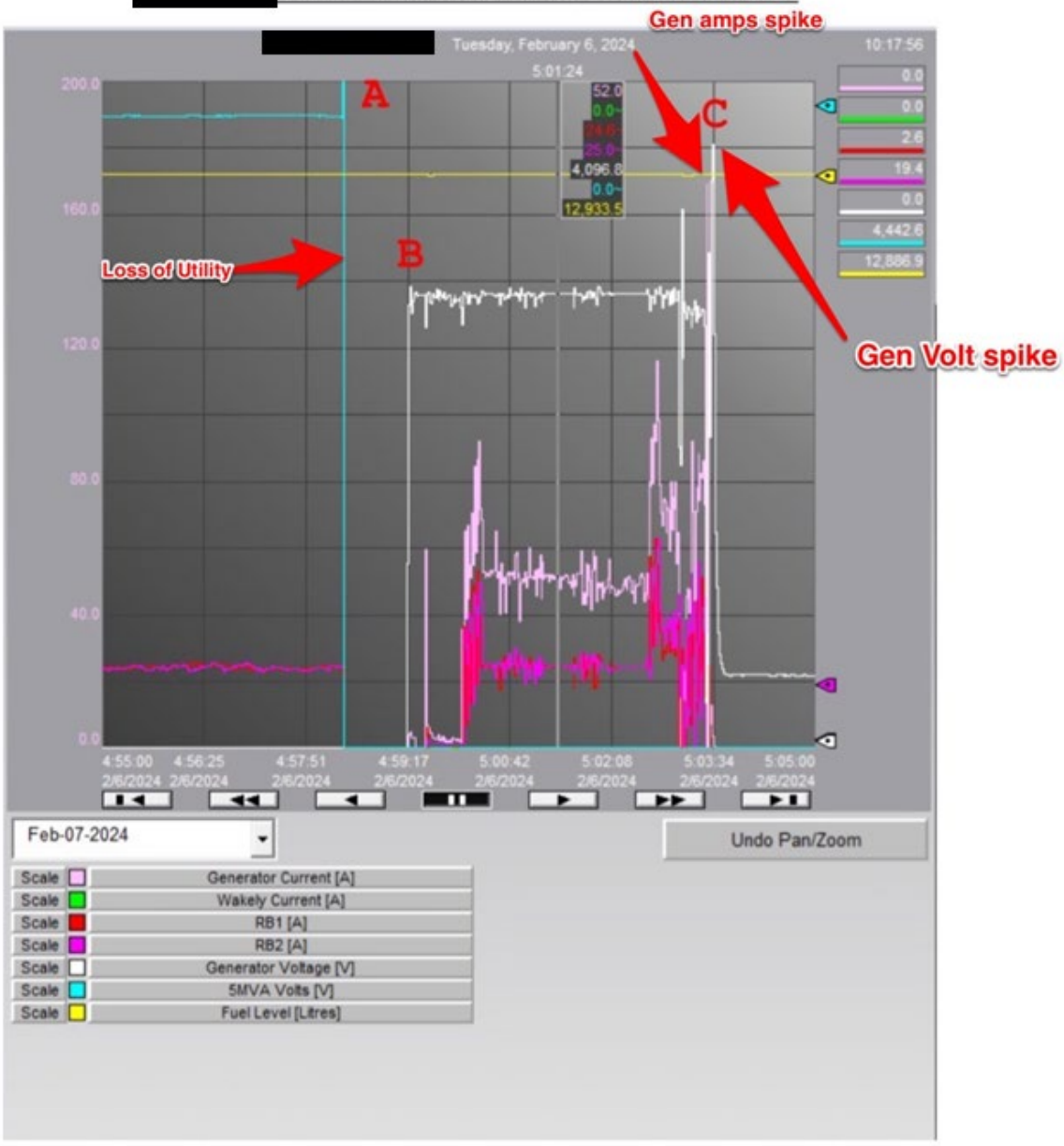
	• With the limited monitoring equipment installed, there was no provision installed to monitor, control or protect the 1500HP generator system at the time of incident with exception of its own over-current protection. • There was no indication of overloading or other voltage issues prior to incident.
Causes and contributing factors	• The evidence appears to be directed at the high voltage junction box located outside and below the tunnel area. The damage within the junction box was unable to be clearly identified. • It is possible the 4160volt cable may have been 'previously' hanging from the structure from a snow load condition or vibration of trains going over the bridge and may have loosened/broke the mounting straps causing stress on the cable connector entering the junction box where the fault seems to have originated.


Generator
GEN CONTROL PANEL
G
1875kVA
1500kW
0.8PF
2400/4160V
SPARE
6x 300amp fuses blew after Generator failed
5MVA
34.5kV–4160
Original Faulted cable
LOCATION OF FAULTED CABLE
45kVA
4160V –
120/208V
SUBSTATION SERVICE
2MVA
4160V–
347V/600V
MOTOR CONTROL CENTER
MCC–2S
MOTOR CONTROL CENTER
MCC–1S
EXISTING 25kVA LOAD
NOTE:
THIS DRAWING WAS PRODUCED FROM LIMITED SITE INVESTIGATION AND INFORMATION PROVIDED. ACCURACY OF INFORMATION HAS NOT BEEN CONFIRMED.
N.T.S.


View of tracks with bridge noted in front of tunnel


Tunnel
Cable mounting structure
Loose conductor laying in snow

[redacted] Tunnel Power Trends for the Event on Feb 6 2024



A- This is where the first ground fault occurred, the feeder to RB2 faulted to the Junction box, the protection relay for our normal power feed opened up the tunnel feeder when the ground fault was detected.

B- Generator started and brought the tunnel back online; inadequate protection allowed the generator to run with a ground fault present.

C- RB2 feeder eventually fully faulted to ground and caused the generator current to quickly spike and then drop when motor protection shut down all fans simultaneously. This resulted in a spike in voltage from the Generator. The trends are not quick enough to capture the true magnitude of the current and Voltage spike. All 300A fuses protecting RB1 and RB2 blew.