

Incident Summary, Final, (Reference #5619558)

SUPPORTING INFORMATION	Incident Date		August 12, 2017	
	Location		District of North Vancouver	
	Regulated industry sector		Passenger Ropeways, Above-surface Ropeway	
	Impact	Injury	Qty injuries	None reported
			Injury description	None
			Injury rating	NA
	Damage	Damage description	<ul style="list-style-type: none"> • <i>Damage to the carriers carriage assemblies:</i> <ul style="list-style-type: none"> ○ <i>Significant impact damage and deformation to multiple sheave beams.</i> ○ <i>Significant side plates damage of multiple sheaves (sheave side plates required replacement).</i> • <i>Impact deformation to a structural member of the hanger of one of the carriers.</i> • <i>Impact damage to lower portion of a cabin also, a cabin window popped out of its molding.</i> • <i>Significant deformation to the end of travel terminal buffer assemblies.</i> • <i>Damage to the wood structure of the return terminal building.</i> 	
			Damage rating	Major
	Incident rating		Major	
	Incident overview		<p><i>The carriers of a double reversible ropeway entered the upper and lower stations without reducing speed, at a speed significantly above the normal established docking speed. The occupied cabins of the carriers (43 passengers and an attendant on downside carrier, 0 passengers and 1 attendant on the upside carrier) make contact with the end of travel buffers with a significantly higher than normal impact force. The impact force causes passenger in the cabin to be thrown forward, resulting in some of the passengers to fall. As a result of the impact, major damage was sustained to the equipment of the carriers and terminal buffer assemblies.</i></p>	
INVESTIGATION CONCLUSIONS	Site, system and components		<ul style="list-style-type: none"> • <i>A 1966 Voest designed and manufactured (Voest is a manufacturer who is no longer active in the manufacturing and service of passenger ropeways) double reversible ropeway (2 carriers on the ropeway, one heading up one heading down), single track-rope and a carrier cabin capacity of 44 plus 1 attendant per cabin.</i> • <i>The carrier carriage assembly (the sheave configuration which rides upon the track rope) is a configuration of 8 sheaves set within a series of rocker beams within a main beam. The cabin hanger is suspended from the main (8) sheave beam assembly.</i> 	

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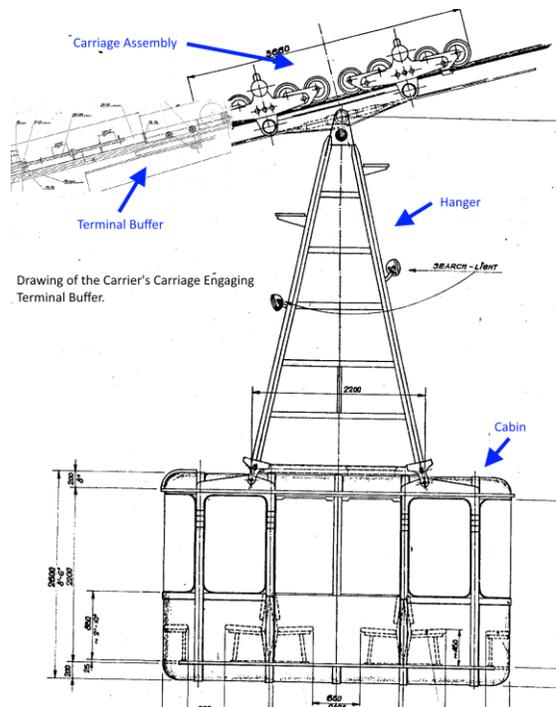
- *Although the ropeway has been acceptance tested at 7 m/s, operating procedures indicate haul rope speed is limited to 4 m/s.*
- *The control safety system requires that the rope speed is reduced as the carrier enters a series of speed zones. Rope speed to be reduced to 2 m/s maximum when the carriers are within 450' (138m) of the stations and then reduce speed again to 1 m/s maximum when the carriers are within 250' (76m) from the stations. A failure of the rope speed to reduce within the required thresholds will result in a ropeway to stoppage.*
- *Carriers enter the station where the carrier carriage engages with a spring loaded terminal buffer. Compression of the buffer causes a limit switch to actuate and stops the operation of the ropeway (docking).*
- *The ropeway control room is located at the drive terminal (bottom station). The speed of the ropeway is controlled manually by the operator, from the control room at the drive station. Operating procedures indicate that the rope speed is to be reduced to .5 m/s as the carriers approach the station and then .25 m/s for docking.*
- *An alarm will annunciate in the control room once the carriers are within 1000' of the stations. The ropeway also has an operator presence push button and foot switch. Failure of the operator to depress either the operator presence push button switch or foot switch once the carriers are within 1000' from the stations will result in a stop of the ropeway.*
- *Supervision System / Control Programmer:*
 - *A supervision system utilizes a mechanical programmer which monitors the position of the cars, drives an operator's display and provides alarm and stop functions. The programmer is made up of a series of rotating cams which engage a multitude of different mechanical limit switches at various orientations of the cams.*
 - *The programmer provides a supervisor function, in which it ensures that the rope speeds are reduced as the cars approach the stations through multiple zones. A failure of the operator to slow the rope speed to the threshold speed value of the specific zone is to result an automatic stop.*
 - *The programmer is driven by a drive shaft and roller chain configuration which is engaged to a sprocket mounted to a bullwheel (programmer reflects the rotational characteristics of the bullwheel).*
 - *At the end of each ride cycle a solenoid operated pawl engages with a gear that is coupled to the programmer through a toothed spring loaded clutch. When the pawl engages, rotation of the gear is stopped causing the toothed drive coupling (clutch) to slip and forcing the mating surface of the coupler to separate (clutch opens) and in turn cause the programmer to stop. A limit switch is used to monitor the opening of the clutch and cause the ropeway to stop upon actuation (clutch slipping will actuate switch).*
 - *The operator display (driven by the programmer) is located in the control room area. The display is visible from the operator's seat. The display indicates the positions of the cars on the ropeway lift line through both a*

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	<p><i>display of numerical values and a mock representation of the ropeway lift line.</i></p> <ul style="list-style-type: none"> ○ <i>The programmer also has a feature in which it provides an input for an audible alarm that annunciates when the approaching carriers are within 1000' (305m) of the terminals. This is to alert the operator to actuate the operator presence switch.</i>
<p>Failure scenario(s)</p>	<p><i>Rope speed failed to be reduced to the established docking speed as the carriers entered the terminal docking areas.</i></p> <p><i>The system that monitors carrier positions and ensures carriers are slowed to threshold speed values failed to detect and stop the ropeway when the carriers approaching the terminal in an over speed condition.</i></p>
<p>Facts and evidence</p>	<p><i>Witness statement provided by the operator (at bottom terminal) on duty at the time of the incident indicate that:</i></p> <ul style="list-style-type: none"> • <i>The operator was distracted and using a personal electronic device as the ropeway was operating.</i> • <i>The operator was holding their foot on the operator present foot switch as the ropeway was operating and was expecting that the audible alarm (annunciates when approaching carriers are within 1000' (305m) of the terminals) would alert them to the approaching carrier at which point they could begin the process of slowing the rope speed.</i> • <i>The operator indicated that they never heard the alarm and never started the process of reducing the rope speed.</i> • <i>The operator did not realize how close the approaching carriers were to the terminals until they saw the carrier entering the terminal building. At that point the operator actuated the service and emergency stop.</i> <p><i>Relying on CCTV video and professional engineers assessment based on the magnitude of the damage, rope speed was estimated to be between 2-4 m/s at the point the carriers entered the docking area and engaged the terminal buffers. (As indicated in the "Site Systems and Components" section of the summary, normal approach speed is .25 m/s.)</i></p> <p><i>The operating contractor's electrical staff discovered that the limit switch utilized in monitoring the programmer's drive coupling position to not be in its correct position. Under normal operating conditions this switch is located so as to actuate when the coupler becomes disengaged and in turn shut down the ropeway. In the position it was found, it would not have actuated upon the coupler becoming disengaged. In the event that the solenoid operated pawl were to engage and cause the coupler to disengage. The programmer would stop rotating and would no longer provide alarm and speed monitoring function. It should also be realized that with the programmer not rotating, the operator's display would also no longer function.</i></p> <p><i>Staff indicated, that during operations in the past, the programmer had become incidentally uncoupled. This was normally immediately detected by the operator, as the display indicating carrier position that is driven by the programmer would stop working.</i></p>

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	<p>Operating contractor's electrical staff and Technical Safety BC safety officer conducting assessment of the programmer operation determined that the control function to the alarm and speed zone functions would have been operational when the programmer is engaged. That is, with the programmer rotating, as intended, the alarm and speed monitoring would have been functional.</p>
<p>Causes and contributing factors</p>	<p>It is certain that the failure of the rope speed to be reduced as the carriers approached the terminals, resulting in an excessive docking speed, was the cause of the impact responsible for the damage sustain to the ropeway equipment.</p> <p>It is very likely, that because of distractions and lack of attention, the operator failed to implement the process of slowing the rope speed as the carriers approached terminals.</p> <p>It is certain that the supervision system failed to detect and stop the over speed condition. This was possibly due the coupling position switch not functioning as intended and it was therefore possible to operate the ropeway without the governor functioning (governor rotating).</p>



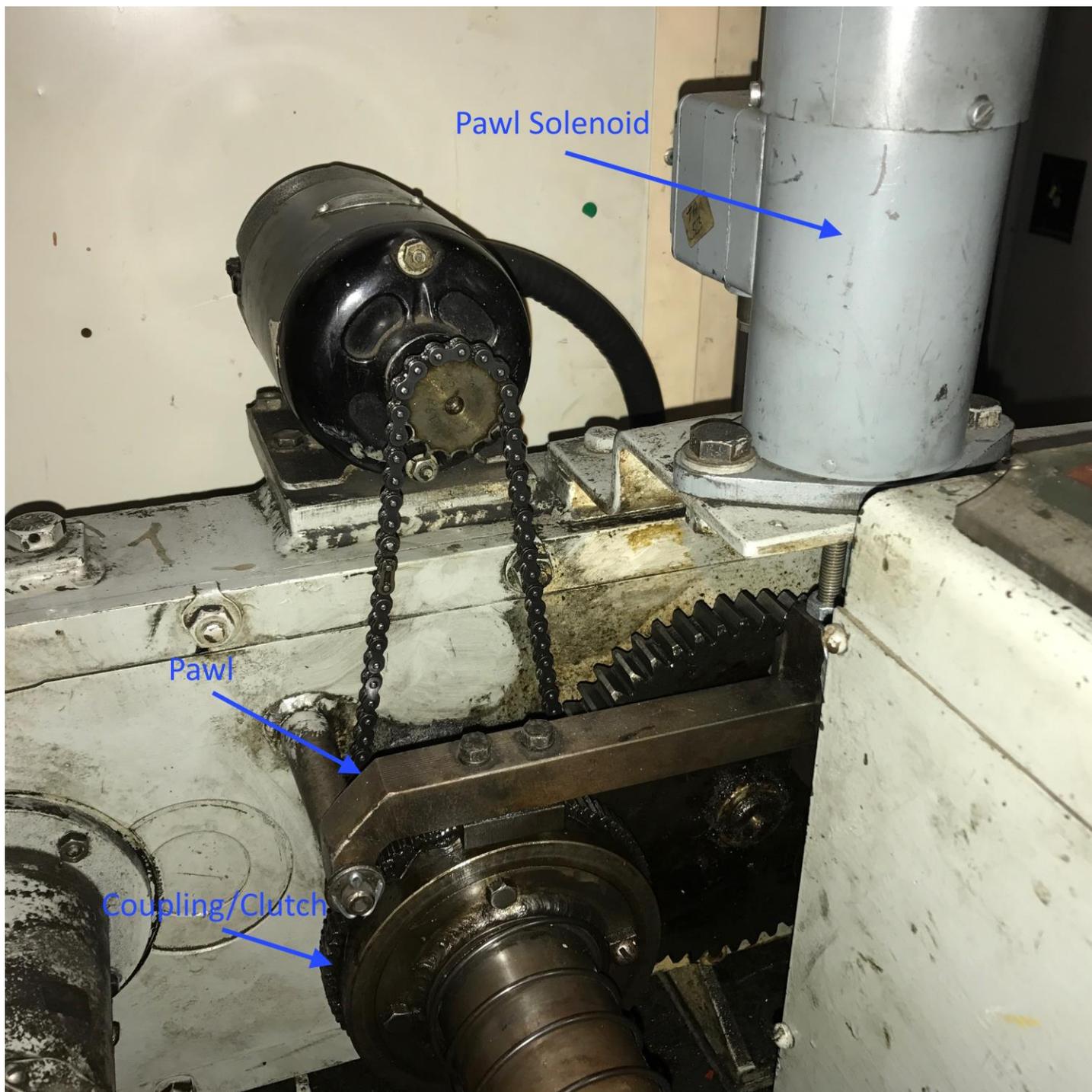
Control Programmer Cams and Switches



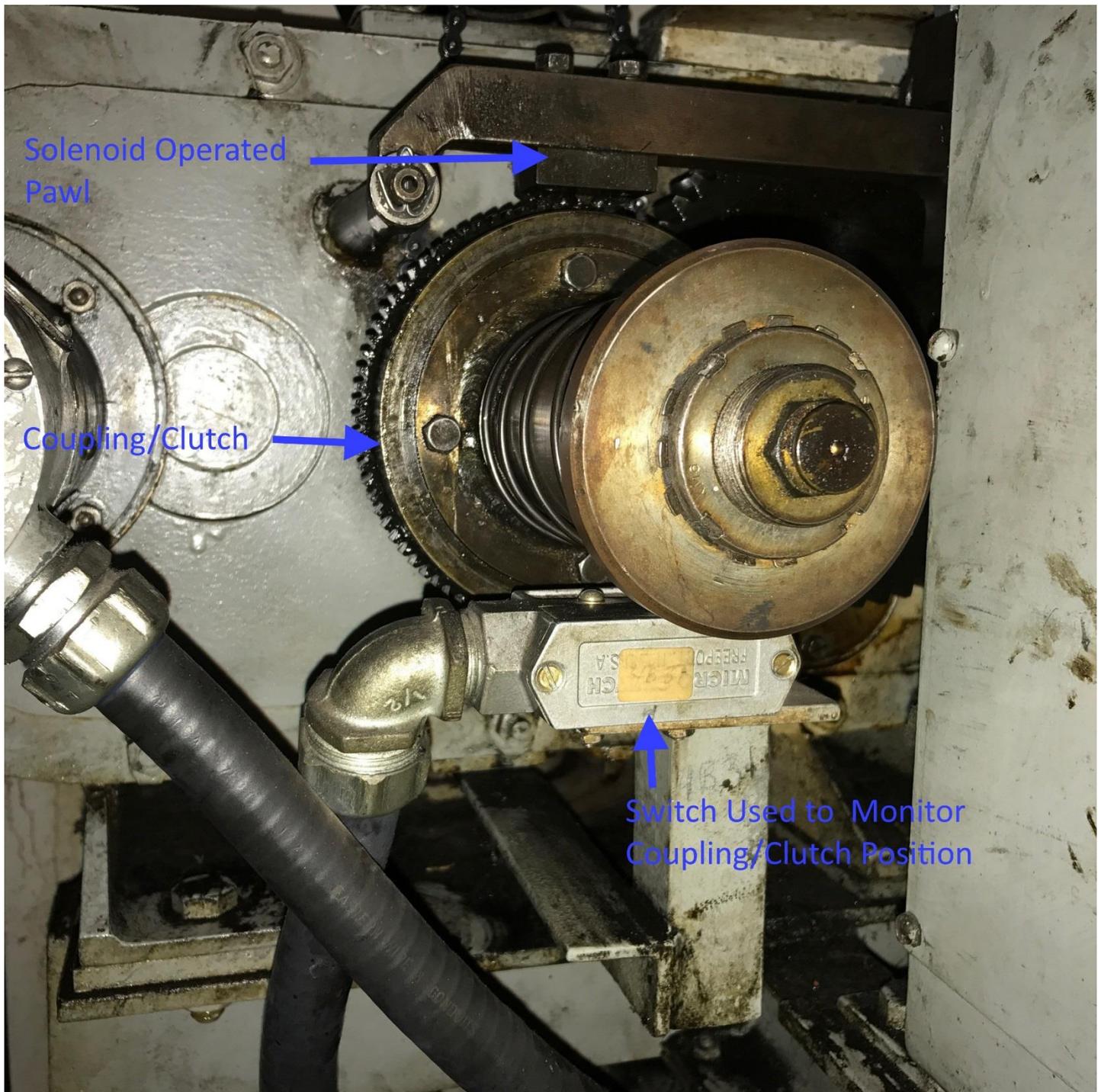
Control Programmer



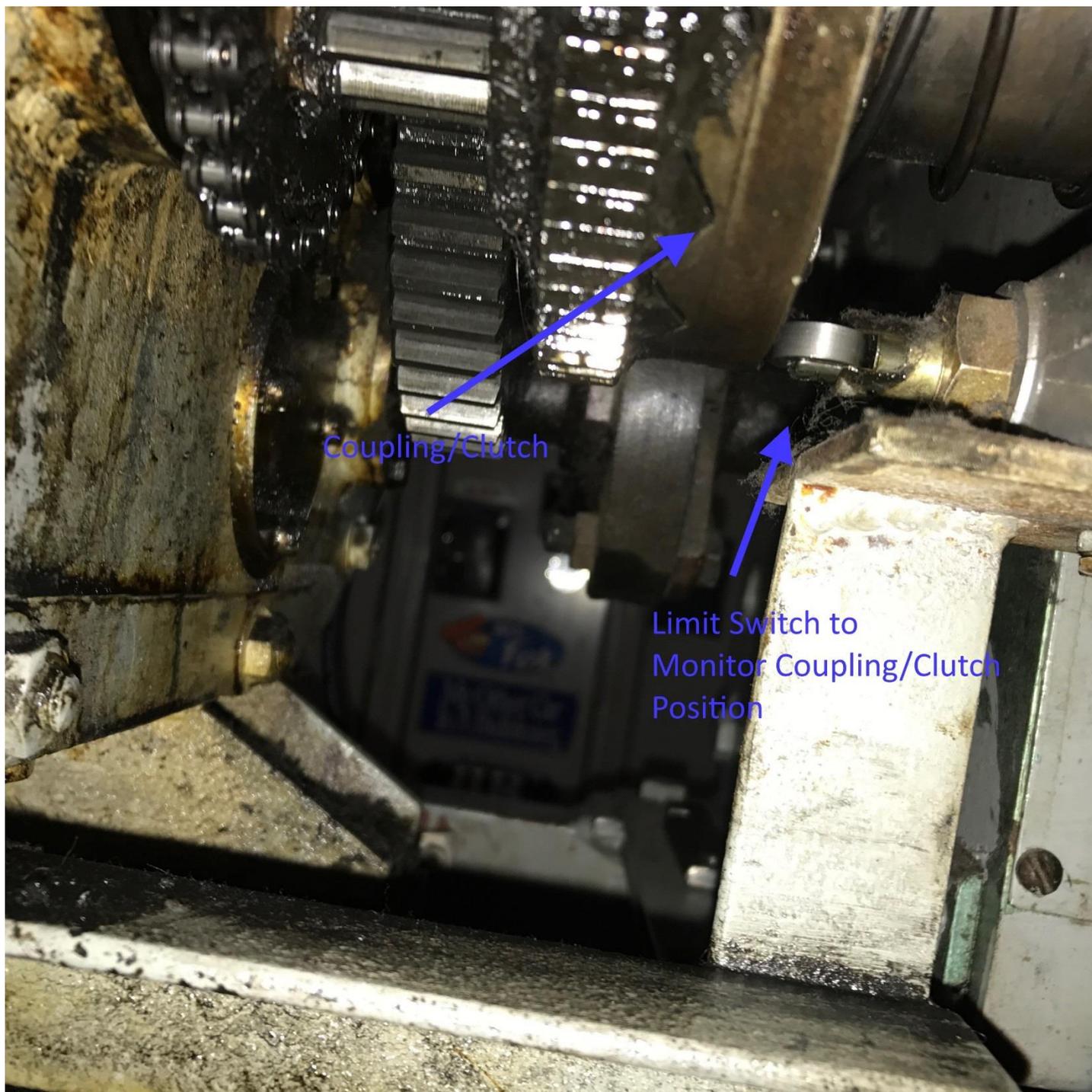
Programmer Coupling/Clutch (1)



Programmer Coupling/Clutch (2)



Programmer Coupling/Clutch (3)



Damage at Bottom Terminal, Carrier Carriage and Buffer



Damage at Top Terminal, Carrier Carriage and Buffer



Damage to Cabin, Bottom Edge and Window

