

MECHANICAL INVESTIGATION INTO THE FAILURES OF WATER PUMP GEARBOXES FITTED TO FIRE TENDERS OPERATED AT ST HELENA AIRPORT

BACKGROUND

GBB were instructed by the St Helena Government to consider mechanical failures observed in the water pump gearboxes fitted to three Airport Rescue and Firefighting (ARFF) vehicles operated at St Helena Airport that resulted in the closure of the airport and suspension of routine commercial operations between 6 and 15 February 2026.

The failure related to the 'eccentric', a subcomponent of the water pump gearbox that drives a secondary 'primer' pump that ejects any air from within the pump system and fills (primes) it with water, removing any airlocks that could prevent or impede the discharge of water. Consequently, the primer pump and its constituent components are critical for correct operation of the ARFF water pumps.

Dr Ross Beesley CEng, a Forensic Engineer at GBB, attended St Helena Airport between Monday 27 July 2026 and Friday 7 August 2026 to conduct his investigation. During this time, he was assisted by St Helena Airport in all aspects of his investigation.

The investigation considered mechanical examination and testing, oil analysis, operational matters of the ARFF vehicles, maintenance and servicing, the water source used by the ARFF vehicles, and the material of the failed component.

CONCLUSIONS

This investigation has made the following conclusions.

The eccentrics each appeared to have failed as a result of disintegration of their structure, and the material properties had altered when compared to an unused exemplar eccentric.

There were numerous cracks throughout the eccentrics, in a multitude of locations and across all planes of the structures. The multiplanar directionality and multiple locations of these cracks did not appear to coincide with any one loading direction. This would suggest that the cracks were not solely caused by the applied mechanical loading, but likely at least partly due to a breakdown of the structure and changes to the material properties.

There was differential staining affecting different regions of the structure that was likely caused by the presence of the oil. The different extent of staining is likely related to the duration of exposure to the oil, where the darker areas were exposed for a longer period of time than the lighter coloured areas. There was also localised staining that had penetrated into some of the cracks, thereby increasing their visual contrast. The presence of staining within the cracks

would suggest that these cracks had been developing for an extended period of time, and long enough for the oil to have penetrated the cracks and have caused the observed staining.

There was also scoring damage to a metal collar that fits around the outer circumference of the eccentrics, which could suggest insufficient lubrication, for example, insufficient viscosity.

The exact point at which the damage first commenced could not be determined from the available evidence. However, the evidence would suggest that it had been developing over an extended period of time.

The eccentric is formed of an elastomer, that while resistant to oils and greases, is susceptible to hydrolysis, a chemical breakdown and decomposition of the structure in contact with water.

Analysis of the oil used in the gearboxes of each of the ARFF vehicles has indicated water contamination at different points in time since the incident. However, no oil samples from prior to the incident were retained or sent for testing. As such, the extent of any previous water ingress is not known. Nevertheless, a potential link has been identified between water exposure and a possible change in the structure and/or properties of the elastomer material, and degradation and/or disintegration of the structure.

At the point that the damage to the eccentrics was observed, they had not yet failed completely and catastrophically, and were still performing their function, despite their developing damage. This meant that there was no means through the routine testing and use of the ARFF vehicles that any developing damage could have been detected.

The eccentric components are housed within a sealed gearbox, and as such there was no way in which the routine inspection and servicing as stipulated by the manufacturer could have detected the developing damage.

In light of the continued functionality of the eccentrics (at the point that the damage was first observed) and the lack of inspection of the eccentrics (as per the operating manual), there would have been no prior indication of any developing failure.

At the point that the damage was first observed, there would also have been no way to predict the remaining working life of the eccentrics, or the duration that the pumps could continue to be operated without sustaining a complete and catastrophic failure of the eccentrics.

Had the eccentrics failed completely, the primer pump would have immediately lost all functionality, meaning that it might not have been capable of removing any airlocks that were within the system. In such a scenario, an airlock could potentially completely prevent, or severely restrict the flow of water through the pump.

Consequently, a complete and catastrophic failure of the eccentrics has the potential to render the ARFF vehicle(s) incapable of discharging any water.

OTHER RELEVANT FACTORS

The original equipment manufacturer (OEM) operating manual for the pump provided to St Helena Airport with the ARFF vehicles stipulated the use of a particular oil within the gearbox (SAE 10 oil). This manual had an issue date of 2014.

In 2021, the pump manufacturer issued an updated manual that stipulated a different oil (SAE 10W40), the viscosity of which is over twice that of the original oil, i.e. a significantly thicker oil. However, the updated 2021 manual was not supplied to St Helena Airport by the service partner following its reissue.

In general, an oil of higher viscosity will be able to support greater loads than an oil with lower viscosity, and as such, can in some circumstances provide greater lubrication properties, and make components less prone to wear than a thinner oil. However, a higher viscosity oil will flow less readily than a lower viscosity oil.

The updated manual was not provided to St Helena Airport until 2026, when the service partner attended to conduct repairs on the gearboxes and replace the damaged eccentrics. This meant that St Helena Airport was using a different oil to that stipulated by the pump manufacturer for a period of approximately five years before they took receipt of the updated manual. On receipt of the updated manual, St Helena Airport subsequently adopted the use of 10W40 oil.

This then raises questions as to why the specified oil was changed by the pump manufacturer, and why the updated manual was not provided to St Helena Airport by the service partner.

Aside from the different oil used in the gearboxes, review of the maintenance and servicing, and routine testing of the pumps *prima facie* suggest that all actions were conducted in accordance with the operating manual.

There is no evidence to suggest that prior to the failure of the eccentrics, St Helena Airport have operated, maintained, serviced, or otherwise managed the ARFF vehicles in any way other than that stipulated by the manufacturer and as set out in the operating manual that had been provided to them.

OTHER OCCURRENCES OF FAILURES

This investigation has identified a number of other, independent cases where the same eccentrics have failed in seemingly identical manners, whereby the structure has disintegrated and crumbled, suggesting that this failure was not an isolated occurrence.

FUTURE RECOMMENDATIONS

While the routine maintenance schedule, and operating and testing procedures for the ARFF vehicle water pumps as conducted by St Helena Airport all appear to be within the specification as stipulated by the manufacturer, a number of actions relating to enhanced monitoring of the eccentrics, as well as a more proactive management strategy with the service provider, have been recommended to help mitigate the risks of similar incidents occurring again in the future.