

Safety Bulletin

Date: November 2024

Safety-critical system failures - steering

This safety bulletin provides safety advice for the NSW mining industry.

Issue

In a one-week period in late October 2024, there were 2 potentially serious incidents in which vehicles lost steering and collided with earth walls. Both incidents were the result of hydraulic failure in the steering circuits of mining-specific mobile plant. These incidents highlight the need to inspect, monitor, and manage safety-critical functions, such as steering, to ensure the safety of workers within or near mobile plant.

Circumstances

Incident 1 – 23 October 2024 surface mine

About 11pm, the steering on a Komatsu HD785-7 water cart appeared to lock up while negotiating a bend in a haul road. The operator applied the brakes and the water cart slid, front first, into a windrow, causing the rear of the water cart to swing out perpendicular to the windrow. The operator was uninjured.

Figure 1: The water cart collided with a bund after steering became difficult



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The mine's investigation identified low hydraulic oil as the cause of the steering failure. The truck design did not include a low hydraulic oil reservoir level light/alarm, so the hydraulic oil leaks went undetected. The hydraulic-powered water pump module for the water cart spray system was plumbed into the truck's hydraulic system, which also controlled the steering. A total of 6 hydraulic leaks were identified with water pump module.

Figures 2 and 3: Hydraulic oil leaks on the water pump drive supply hose fitting, and staff test fitting



The truck design included:

- an accumulator in the steering circuit
- a 24 volt electric secondary steering pump that automatically activated, but was significantly harder for the operator to steer, requiring a lot more effort
- both primary and secondary steering relying on the same hydraulic oil tank for supply. The loss of hydraulic oil meant that even though the secondary pump operated, there was no oil to recharge the accumulator.
- an indicator light when secondary steering activates. The secondary steering pump indicator light was a lagging indicator of the hydraulic failure.

The mine operator and truck original equipment manufacturer (OEM) plan to:

- develop and install a low level hydraulic warning visual and audible alarm and interlock to shut down auxiliary systems that may impair steering or braking function
- update the introduction-to-site process to include conformance with AS5364:2021, specifically addressing add-on features and auxiliary systems that modify OEM steering circuit design
- update maintenance and prestart inspections to include looking for oil leaks and checking oil levels.

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Incident 2 – 29 October 2024 underground mine

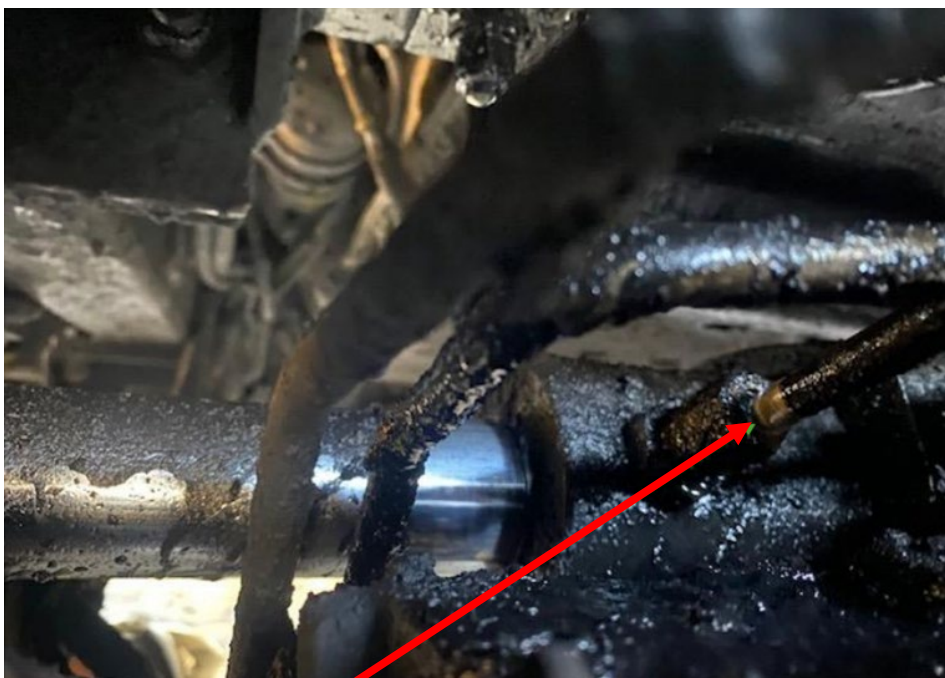
About 7:55am, 2 workers were in an underground coal mine personnel transport, travelling outbye in the main travel road when they lost steering control. The vehicle swerved and clipped a rib (side wall), with the brakes pulling the vehicle up just short of the rib on the far side of an intersection. Although the occupants were uninjured, the vehicle's front suspension trailing arm and bracket was damaged.

Figure 4: A drift runner lost steering and collided with the rib in a main travel road



An inspection of the vehicle identified the hard pipe had come out of the steer cylinder fitting,, dumping the hydraulic oil, and causing the machine to lose power steering.

Figure 5: Failed fitting on steer cylinder



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The investigation identified the vehicle had recently returned from overhaul. Although the fitting was tightened, it was believed it was not given the additional one-and-a-quarter turns required to cause the olive to deform and 'bite' into the hard pipe, as specified in the supplier's assembly process. In addition, the supplier of the steering components had upgraded the hard pipe to stainless steel with thicker walls, so strict adherence to the process was more critical to achieve a satisfactory joint.

Figure 6: Failed fitting showing no engagement marking on pipe from crush olive



During the investigation, the steering component supplier advised there had recently been a similar failure during an overhaul, but the failure occurred while the machine was still at the service facility. Consequently, the steering component supplier has advised they would:

- test thinner-walled, stainless steel piping that will meet the pressure requirements, and still prevent corrosion
- supply preformed and assembled hard piping as a kit ready to install.

Recommendations

Designers and suppliers should:

- assess all reasonably foreseeable failure modes and implement controls to ensure all safety-critical functions remain operational until the mobile plant can be brought to a safe stop
- ensure pre-failure warning devices are present for all safety critical systems on mobile plant
- ensure any changes to configuration or components in safety-critical systems are fully assessed and verified as having no impacts to health and safety, or safe operation of the mobile plant
- ensure maintenance, inspection and testing requirements for safety-critical system components are clearly identified and practically achievable.

Mine operators should:

- ensure the person who manages or controls mobile plant:
 - reviews maintenance records and/or inspects plant where safety-critical system components have been overhauled, replaced, or changed
 - implements a process of recommissioning checks with supervisor sign-off to verify the plant is safe to return to service without maintenance induced faults/failures

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- implements a process to ensure maintenance records relating to safety-critical systems are kept in the plant safety file
- ensure safety critical systems are inspected, tested, and maintained so that these systems operate correctly and remain effective
- ensure pre-operation checks:
 - identify the safe condition of safety-critical systems by using an indicator test such as fluid level, check for leaks (water, coolant, oil, fuel, etc), warning light/alarm activation test, lock-to-lock steering functionality, drive-through brake, etc
 - are rigorously carried out by competent personnel with all identified safety-critical defects being assessed by a competent person before the mobile plant is returned to service
- operators, supervisors, and maintenance personnel involved with mobile plant are familiar with all safety-critical systems, including warning systems that identify failure of safety-critical systems, and are trained and competent for their tasks
- ensure the competency of tradespersons working on safety critical systems. They should be assessed and verified to ensure work is carried out effectively, and does not pose a risk to the operation of the mobile plant.

In this safety bulletin, safety-critical systems refer to those systems that are critical for the safe operation of the mobile plant, including but not limited to steering, brakes, warning systems, operator restraint and operator protective devices.

Note: Please ensure all relevant people in your organisation receive a copy of this safety bulletin and are informed of its content and recommendations. This safety bulletin should be processed in a systematic manner through the mine’s information and communication process. It should also be placed on the mine’s common area, such as your notice board where appropriate.

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| Document control | |
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| CM10 reference | RDOC24/210888 |
| Mine safety reference | SB24-09 |
| Date published | 22 November 2024 |
| Authorised by | Chief Inspector Office of the Chief Inspector |

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