Resources Regulator
Department of Regional NSW

Investigation report

Dangerous incident involving a worker at Attunga Limestone Mine

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Executive summary

Overview of incident

A contract maintenance field service technician suffered crush injuries and was trapped on 30 November 2022. The worker was employed by CJD Equipment Pty Ltd was conducting maintenance work under the tilted cab of a Volvo L220H wheel loader at Attunga Limestone Mine. The cab suddenly lowered onto his upper body, trapping him between the cab and the chassis of the loader. The incident had a high potential of resulting in serious or fatal injury.

The task

The worker attended the Attunga site, which is operated by Graymont (NSW) Pty Ltd on the date of the incident to replace failed cab mounts on a Volvo L220H wheel loader. He conducted this repair in the mine's service bay with no other CJD or mine workers present.

Prior to commencing the cab mount replacement, the worker used his laptop computer to consult Volvo's Product Support Information System (PROSIS) service manual. PROSIS provides step-by-step instructions describing the steps for the task. In the manual's instructions for Viscous cab suspension, changing all units, after securing and de-energising the machine, the worker is instructed to 'Tilt the cab according to: Cab, position 1'.

The PROSIS instructions relating to Cab, position 1 directs the worker to use a manual hydraulic pump to raise the cab to approximately 30 degrees where it can be secured by a lock pin.

Issues with raising the cabin

The worker began raising the cab of the loader using a built-in manual hydraulic pump that extended a hydraulic ram that tilted the cab upwards from the chassis by pivoting on a hinge point. The cab opened on the right-hand side of the machine as it is hinged on the left-hand side. The worker noticed that as the cab was being raised, various harnesses and hose straps located under the cab were becoming tight. He pumped the cab up in stages, approximately 100 mm to 200 mm at a time, stopping frequently to check the machine from the ground to assess tension of the harnesses and hose straps. If any harnesses or hose straps appeared overly strained, he disconnected or loosened those items to avoid damaging them as he raised the cab further. The worker reached under the raised loader cab to conduct this work without using a support device (such as a wood block).

When the worker had the cab tilted to an approximately 600 mm opening above the chassis, he noticed that several more harnesses and hydraulic hoses were becoming tight. At that point he decided that raising the cab was, in his words, 'becoming complicated' so he did not attempt to raise the cab further to position 1. He changed the cab mounts without reaching position 1 and without the raised cab being secured by the lock pin or using a support device, instead relying solely on the hydraulic ram to keep the cab raised.

Issues with lowering the cabin

After he successfully replaced the cab mounts, the worker turned a valve on the hydraulic pump to the 'down' position and commenced pumping the cab incrementally down towards its resting position on the chassis. He stopped pumping the cab down when it was tilted to height around 310 mm or 340 mm above the chassis, pausing to reconnect and tighten harnesses and hose straps that he had altered whilst raising the cab. The worker entered under the tilted cab to tighten a hose strap, placing his upper body under the suspended cab which was held in place only by the hydraulic ram. No support device was in place. At that point the cab self-initiated a descent onto the worker's upper body, pinning his upper chest, head and shoulders between the cab and the chassis.

The hydraulic tilt cylinder used to raise the cab had an in-built 'float' function that caused the cab to self-lower without warning at approximately 300–330 mm above the chassis.

The rescue of the worker

The worker was in a crush position underneath the cab for about 3–5 minutes. He had been working alone. The worker was able to call out for help from mine workers who were having a meal break in a nearby room. The mine workers rescued the worker by raising the cab.

Mine workers called emergency services and stayed with the worker until the ambulance arrived on site. The worker was transported via ambulance to Tamworth Hospital, where he was assessed in the Emergency Department and released that evening. The worker received treatment for soft tissue injury but was not admitted as an in-patient at hospital.

The incident scene was preserved with the mine operator notifying the Regulator.

Direct or primary causes of the incident

The direct or primary cause of the incident was:

- Unsafe condition: The design of the cab tilt function gave rise to a crush hazard in that there was potential for a worker to place their torso, head and/or limbs in the 300–330 mm gap between the loader's cab and chassis in circumstances where the cab may self-lower with limited retardation and without warning or control
- Unsafe act: The worker positioned his upper body, head and limbs in the gap between the raised cab and chassis that was slightly larger than 300–330 mm, just above the height at which the float function initiates, in the absence of secondary support (in addition to the hydraulic ram) i.e. the worker entered under a suspended load relying upon only the hydraulic ram and without the provision of any secondary support such as a wood block placed to support the cab.

Ineffective risk controls or causal factors that permitted the direct causes to exist

The following ineffective risk controls or causal factors permitted the direct causes to exist:

- Aftermarket cables and harnessing installed under the cab resulted in the worker perceiving that raising the cab to position 1 where it could be secured with a lock pin was impeded
- Access by a worker's torso, head and/or limbs to the 300–330 mm crush hazard between the loader's cab and chassis was controlled by lower order (administrative) controls, that proved inadequate or ineffective, not higher order (engineering) controls that were implemented after the incident
- The worker was not provided with information, instruction or training, nor did he have the requisite experience, necessary to instil knowledge or awareness of the existence of the float function prior to the date of the incident
- The following acts or omissions on the part of the worker contributed to his exposure to the risk (working under a suspended cab without a support device):
    - Did not use a support device under the suspended cab that were available nearby and in his work vehicle
    - Did not risk assess a change to the task as required by CJD and Graymont procedures
    - Did not contact his CJD supervisor or a Graymont representative when the work task changed as was required by CJD and Graymont procedures
    - Did not account for warnings provided in the Volvo PROSIS Service Manual

— Working to self-imposed time constraints (no undue time pressure was exerted by Graymont or CJD to complete the task).

Recommendations

It is recommended that:

1. **Manufacturers, designers, importers and suppliers of mobile plant** used at a workplace must, so far as is reasonably practicable, develop and implement safe systems of work (including procedures) directed toward:
   a. assessing health and safety risks including those arising when mobile plant is used in a way not intended by the designer as a result of reasonably foreseeable or predictable worker behaviour such as:
      i. taking the 'line of least resistance' or self-imposing time constraints when carrying out a work task, to reduce time and effort, that may compromise safety
      ii. not complying with procedural requirements
      iii. working without adequate information, instruction, training and / or experience
      iv. reacting to a real or perceived business requirement to keep mobile plant operational.
   b. applying the hierarchy of controls to eliminate or minimise health and safety risk that may arise including (but not limited to) risk arising from:
      i. suspended loads
      ii. crush hazards
      iii. infrequent work tasks such as inspection, servicing, maintenance and repair
      iv. reasonably foreseeable or predictable worker behaviour such as that set out at 1.a (above).
   c. ensuring that when eliminating or minimising health and safety risk arising from work around crush hazards and/or under suspended loads:
      i. Mechanisms that hold a suspended load at any position in the cycle of opening or closing are designed to be inherently safe between the closed and open positions where a person can be positioned under the suspended load.
      ii. A suspended load will not release from a position that appears to be stable without the operation of controls.
      iii. Consideration should be given to geometrical factors relating to crush hazards by increasing the minimum gap between moving parts or by reducing the gap to prevent entry of parts of the body.
      iv. Administrative controls, such as procedures and information or warnings in OEM manuals, are not solely relied upon to control risks to health and safety where the implementation of engineering controls to further reduce the risks are reasonably practicable.

      NOTE: Duties of manufacturers, designers, importers and suppliers also apply if the original design is changed or modified.
   d. carrying out, or arranging the carrying out of, calculations, analysis, testing or examination necessary to achieve 1.a to c. (above) including (but not limited to) verifying that risk controls, such as engineering controls, operate pursuant to OEM specifications.

      NOTE: Where a principal designer of mobile plant sub-contracts the design of systems or components and supplies the subcontracted designs, the principal designer must carry out any calculations, analysis, testing or examination that may be necessary to verify that engineering controls operate pursuant to OEM specifications.

e. giving adequate information to each person to whom the mobile plant is provided concerning:
   i. the results of the matters set out at 1.d (above)
   ii. conditions necessary to ensure the mobile plant is without risks to health and safety when used for a purpose for which it was designed or manufactured or when carrying out any activity (including inspection, servicing, maintenance or repair).

2. **Duty holders whose business or undertaking involves inspection, servicing, maintenance and repair of mobile plant** review their health and safety management plan to ensure it provides safe systems of work directed toward:
   a. eliminating or minimising health and safety risk arising from:
      i. work under suspended loads, around crush hazards and lone work
      ii. infrequent work tasks such as inspection, servicing, maintenance and repair
      iii. reasonably foreseeable or predictable worker behaviour such as that set out at 1.a (above).
   b. information, instruction and training competency programmes that incorporate:
      i. role-based training needs analysis to identify role-specific core competencies, risks to health and safety arising from work performed (incl. those listed at 2.a.i. above) and information, instruction, training and experience necessary to develop role-specific core competencies
      ii. development and execution of a training plan to address matters identified at 2.b.i. (above) including structured, formal and comprehensive information, instruction and training (beyond the mere reading of OEM manuals) where identified by a case-by-case risk-based assessment

         NOTE: Ad-hoc unstructured information, instruction and training, including the mere reading of OEM manuals, may be adequate in the case of risks to health and safety that are low but not those that are moderate to high i.e. the level of structure, formality and comprehensiveness of information, instruction and training increases with the level of health and safety risk
      iii. transparent and accountable means of monitoring implementation of training plans through to finality.
   c. means of verifying worker compliance with procedures and application of information, instruction and training concerning work under suspended loads, around crush hazards and lone work.

3. **Workers** who perform work under suspended loads or around crush hazards associated with mobile plant or lone work:
   a. Take reasonable care for their own health and safety by:
      i. not entering under a suspended load without a secondary support device in place
      ii. not working around uncontrolled crush hazards
      iii. complying with procedures to control risks to health and safety arising from lone work.
   b. Comply with any reasonable instruction and co-operate with any reasonable policy or procedure imposed by another duty holder directed toward:
      i. controlling those risks
      ii. assessing changed circumstances that may impact upon the effectiveness controls to eliminate or minimise risks to health and safety
      iii. suspending work and contacting a supervisor when confronted with changed circumstances to establish risk controls necessary for work to proceed safely.

4. It is recommended that **mine operators** review and monitor implementation of a contractor health and safety management plan by:
    a. verifying contractor compliance with site rules whilst working under suspended loads and around crush hazards associated with mobile plant
    b. monitoring, including conducting safety observations, of contractors working alone.

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1. Purpose of the report

This report describes the mining workplace incident investigation (the investigation) conducted by the NSW Resources Regulator (the Regulator) into the cause and circumstances of a dangerous incident involving a contract maintenance worker at Attunga Limestone Mine located at Attunga NSW on 30 November 2020.

2. Investigation overview

2.1. Major safety investigations

The Regulator investigates major workplace incidents in the NSW mining, petroleum and extractives industries. The Regulator carries out a detailed analysis of incidents and report findings to enhance industry safety and to give effect to its *Compliance and enforcement approach*.

2.2. Legislative authority to investigate

Investigators are appointed as government officials under the *Work Health and Safety (Mines and Petroleum Sites) Act 2013* and are deemed to be inspectors for the purposes of the *Work Health and Safety Act 2011* (WHS Act). The Regulator has also delegated some additional functions to investigators including the power to obtain information and documents for the purpose of monitoring compliance with the WHS Act.

2.3. Regulator response

The incident was reported to the Regulator on 30 November 2020. The immediate response of the Regulator was to deploy an inspector to the site on 30 November and 1 December 2020 to undertake an initial assessment of the secured incident scene.

The Regulator commenced an investigation on 1 December 2020. The investigation included:

- Scene assessments
- Notices being issued
- Witness interviews
- Obtaining information and documents from relevant parties
- Issuing an Investigation Information Release.

3. The incident

3.1. Parties involved

3.1.1. Mine operator and holder

Attunga Limestone Mine (Attunga) is operated by Graymont (NSW) Pty Ltd (Graymont) [ACN 004 776 989]. Graymont has lime and limestone operations across eastern Australia including 4 quarries and plants in New South Wales. Graymont acquired Attunga from the previous mine operator, Sibelco Lime Pty Ltd (Sibelco), on 2 August 2019 and adopted Sibelco standards and procedures upon acquisition of the business.

3.1.2. Plant supplier / maintenance contractor

CJD Equipment Pty Ltd (CJD) [ACN 008 754 523] was the employer of the worker at the time of the incident. CJD is the exclusive Australian dealer of Volvo Construction Equipment products.

CJD has supplied Volvo plant and provided associated plant maintenance services at Attunga for approximately the last 15 years. Sibelco, the previous mine operator, entered into a contract for the purchase and ongoing maintenance of two Volvo wheel loaders at Attunga in June 2018: a smaller L180H model and a larger L220H model (involved in the incident). Graymont assumed the

contractual rights and obligations of Sibelco after it acquired Attunga in August 2019 and CJD has continued to provide repair and maintenance services to Graymont for the 2 Volvo wheel loaders at Attunga since that time under the loaders' respective Service Agreements, as well as a *Repair and Maintenance Master Agreement* with Sibelco.

3.1.3. Plant importer

There is dispute as to whether, at law, CJD or Volvo Finance Australia Pty Ltd (VFA) [ACN 071 774 233] was the importer of the Volvo L220H wheel loader serial number (S/N) 7352 into New South Wales.

3.1.4. Injured person

The injured person, 44, was employed as a contract maintenance worker by CJD at the time of the incident. He commenced employment with CJD as a resident field service technician on 3 October 2018 and was inducted onto the Attunga site on 10 October 2018. The worker had attended Attunga at least 5 to 6 times during the 18 months preceding the incident.

The worker is a qualified diesel mechanic with 15 to 20 years' experience working in the mining industry and for original equipment manufacturers (OEM). Before the date of the incident, he had conducted the task that resulted in his injury on only previous occasion that happened to be at Attunga on 9 October 2019.

3.2. The mine

The Attunga Limestone Mine and Manufacturing Plant is approximately 20 km northwest of Tamworth and 1.2 km northeast of Attunga. Open cut mining operations, using drilling and blasting, produce limestone feed for the processing plant. Two vertical kilns produce lime which is despatched in bagged or bulk form. Crushed rock products are also produced. The entirety of Attunga Limestone Mine is on mining lease ML 1394, for which Graymont is the title holder. There were about 25 workers permanently employed on site at Attunga.

3.3. Incident location

The incident involving the worker occurred at Attunga's service bay, a covered area used for maintenance of mobile plant which is located near the southwest corner of ML 1394. The service bay is close to a meal room and toilets but away from the mine's production area.

3.4. Mobile plant involved

The Volvo L220H wheel loader S/N 7352 involved in the incident had an operating weight of about 32.8 t and an operating load of 10.1 t. It could be configured for a range of applications including mining, quarrying, steel mills, agriculture and logging.

The loader was purchased by Sibelco and delivered to Attunga on 21 June 2018. It was subject of a service agreement between Sibelco and CJD under that CJD is to provide maintenance and repair services for the loader for 5 years or 15,000 machine hours. In addition to the loader, Sibelco purchased a Volvo L180H wheel loader under a service agreement with CJD at the same time.

3.4.1. Cab tilt function

The cab of the loader could be tilted to 2 positions (30° and 70°) using a manually operated hydraulic pump. This feature provided increased access for the purpose of service and maintenance.

The cab was tilted by first placing a hinge on the left-hand side of the loader, around which the cab pivots as it was raised by a hydraulic ram. The operator raised the cab using the machine's hydraulic cab jacking mechanism, which was manually pumped and tilted the cab in stages with each pump of the handle. Position 1 was achieved when the cab was tilted approximately 30 degrees at which time it was supported by a lock pin – a sliding bolt fixed to the frame of the loader.

There was an 'up/down' valve located on the hydraulic pump on the right-hand side of the loader. The operator selected the valve direction depending upon whether the cab was to be raised or

lowered. When the valve was turned to the 'down' position the cab was returned to its resting position by pumping the hydraulic handle. This action lowered the cab in stages until it was at a pre-defined height above the chassis. At this point, the cab was designed to freefall and lower the remainder of the distance by itself.

The self-lowering design of the cab from a pre-defined height to its resting position is known as the 'float' function. According to the OEM (Volvo), incorporation of the float function into the design of the hydraulic cab tilting mechanism is necessary to ensure a low level of cab noise, cab vibration and to prevent premature damage to the hydraulic cylinder attachment point and cab cylinder attachment point. The float function also prevents cab pivot failure caused by the retaining load of the cab on the rigid hydraulic cylinder.

Although the OEM procedure stated that the cab self-lowered or 'enters float' (a reference to the height above the chassis at which the freefall or self-lowering float function initiates) at 200 mm above the chassis, this was proven to be inaccurate during post-incident field testing.

Post-incident field testing performed by CJD in the presence of a mechanical engineer and investigators from the Regulator established that the float function initiated when the cab was raised 330 mm above the chassis contrary to the OEM design specification of approximately 200 mm.

Further testing by CJD and a consulting engineer engaged by the Regulator, also in the presence of investigators from the Regulator, established that the height at which the cab entered float was likely closer to be 300 mm in height when measured from the top edge of the chassis to the bottom edge of the underside of the cab. Due to the 30 mm discrepancy in measurements, and adopting a conservative approach, the height above the chassis at which the cab enters float is referred to as '300–330 mm' throughout this report.

Figure 1 The loader in the Attunga service bay following the incident

Figure 2 Right-hand side of the loader in the fully elevated position 1 with the lock pin engaged in the Attunga service bay following the incident (Note: the wooden chock was placed following the release of the worker)

Figure 3 Right-hand side of the loader with cab tilted at position 1 and the lock pin in place to support the cab. A 450 mm green device is placed in the gap between the cab and the chassis for measurement purposes

Figure 4 Cab lock pin in locked position 1, supporting the raised cab

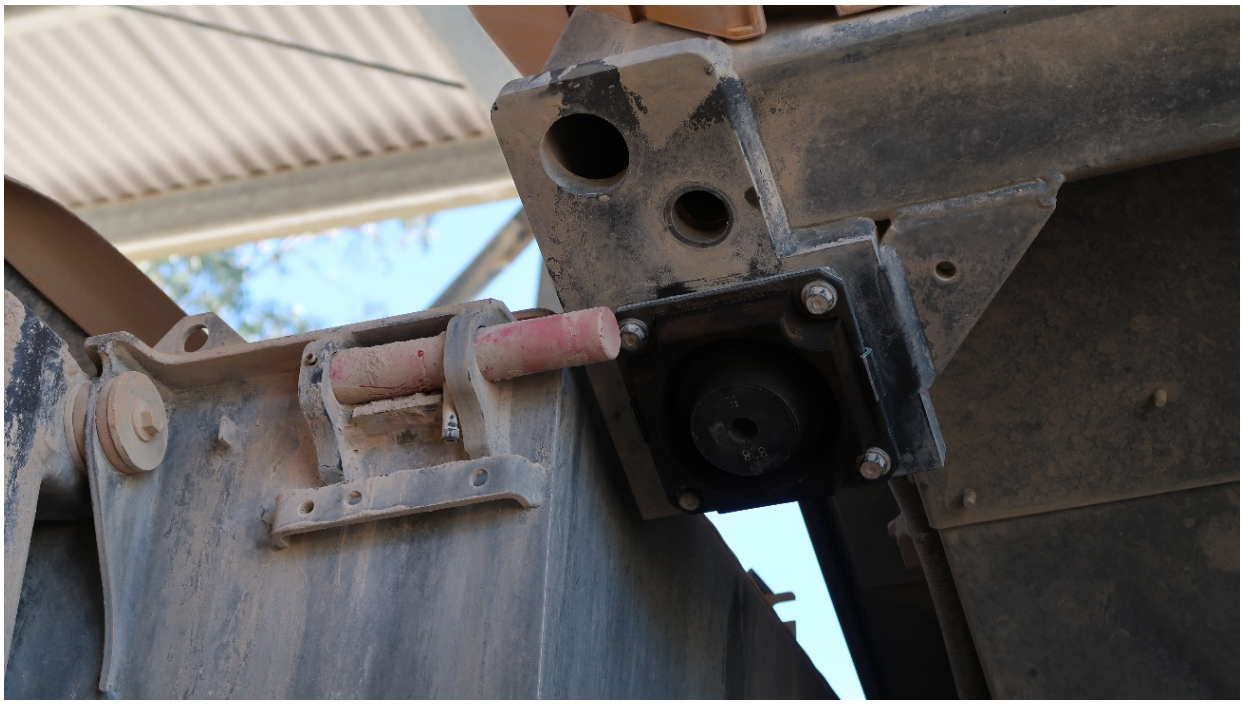


Figure 5 Hydraulic pump and handle used to raise and lower cab

3.5. The incident

3.5.1. Pre-incident

Approximately 6 to 8 weeks before the incident, cab mounts on the loader failed and rendered it unusable due to excessive vibration experienced by an operator. The loader was subsequently parked-up on Attunga's 'ready line' awaiting delivery of parts for replacement of the cab mounts by CJD. It was the responsibility of the worker to organise replacement parts and attend the mine to conduct the repair. The worker scheduled the replacement of the cab mounts on the loader to occur on 30 November 2020.

3.5.2. The incident

3.5.2.1. Preparation for task

The worker arrived at the Attunga site about 8 am on 30 November 2020. On arrival, he signed in at the front office and then greeted the production superintendent, who was busy in a site meeting. The worker attended the onsite office to complete requisite paperwork with the assistance of the site maintenance supervisor. The worker completed a permit to work form and a job risk assessment for the planned work on site which he was required to complete as a contractor working at Attunga. Both forms were reviewed and signed by the maintenance supervisor.

The worker drove his CJD service truck to Attunga's covered service bay and arranged for the loader to be moved into the service bay. When he exited his service truck, he left his personal emergency notification device (SPOT Gen3 Emergency Beacon) in the vehicle instead of wearing it on his person as required by CJD. Before commencing work on the loader he began completing a service report, a document required by CJD which included a 'Take 5' risk assessment. The worker then commenced working on the loader about 10 am, beginning by chocking, isolating and tagging the machine.

3.5.2.2. Raising the cab

Before commencing the cab mount replacement, the worker used his laptop computer to consult Volvo's PROSIS service manual which provided step-by-step instructions describing the necessary steps for the task. The manual's instructions for 'Viscous cab suspension, changing all units' provided that, after securing and deenergising the machine, the worker was instructed to 'tilt the cab according to: Cab, position 1.' The Volvo PROSIS Service Manual instructions relating to 'Cab, position 1' directed the worker to use a manual hydraulic pump to raise the cab to approximately 30 degrees where it could be secured by the lock pin.

The worker began raising the cab of the loader using a built-in manual hydraulic pump, which extended a hydraulic ram that tilted the cab upwards from the chassis by pivoting on a hinge point. The cab opened on the right-hand side of the machine as it was hinged on the left-hand side. The worker noticed that, as the cab was being raised, various harnesses and hose straps located under the cab were becoming tight. He pumped the cab up in stages, approximately 100 to 200 mm at a time, stopping 5 to 6 times to check the machine from the ground to assess tension of the harnesses and hose straps. If any harness or hose strap appeared overly strained, he disconnected or loosened the items to avoid damaging them as he raised the cab further. The worker reached with his arms under the raised loader cab to conduct this task without a support device in place.

When the worker had the cab tilted to approximately 600 mm above the chassis, he noticed that several more harnesses and hydraulic hoses were becoming tight. At that point, he decided that raising the cab was, in his words, 'becoming complicated' so he did not attempt to raise the cab further to position 1. He instead changed the cab mounts without the cab reaching position 1 and being securely supported by the lock pin at that position, relying solely on the hydraulic ram to keep the cab raised, and without using a support device.

3.5.2.3. Lowering the cab – the incident

After the worker had successfully replaced the cab mounts, the worker turned the 'up/down' valve on the hydraulic pump to the 'down' position and commenced pumping the cab down towards its resting position on the chassis.

The worker stopped pumping the cab down when it was tilted to, on his estimation, a point approximately 400 mm above the chassis (post-incident testing established it to in fact be approximately 310 mm or 340 mm), pausing to reconnect and tighten harnesses and hose straps that he had altered whilst raising the cab. The worker entered under the tilted cab to tighten a hose strap, placing his upper body under the suspended cab, which remained held in place only by the hydraulic ram and without placing a support device under the cab. At that point, the float function initiated and the cab free fell onto the worker's upper body, pinning his upper chest, head and shoulders between the cab and the chassis.

3.5.2.4. Emergency response

The worker was alone and was trapped without his personal emergency beacon. He was able to call for help from mine workers who were in a meal room nearby. The mine workers were able to free the worker after he was pinned under the cab for 3 to 5 minutes.

The rescue was complicated by the fact that the 'up/down' valve was not labelled so that, while pinned by the cab, the worker had to give verbal instructions to his rescuers to turn the valve around in order to pump the cab upwards.

If the worker had been wearing the personal emergency beacon at the time of the incident, he may have been able to press an 'SOS' button on the device should nearby mine workers not have been available to assist.

The incident occurred at 11:50 am. Mine workers called emergency services and stayed with the worker until the ambulance arrived on site 26 minutes later. The worker was transported via ambulance to Tamworth Hospital where he was assessed in the emergency department and released that evening. The worker received treatment for soft tissue injury without admission as an in-patient to the hospital.

The incident scene was preserved with the mine operator notifying the Regulator.

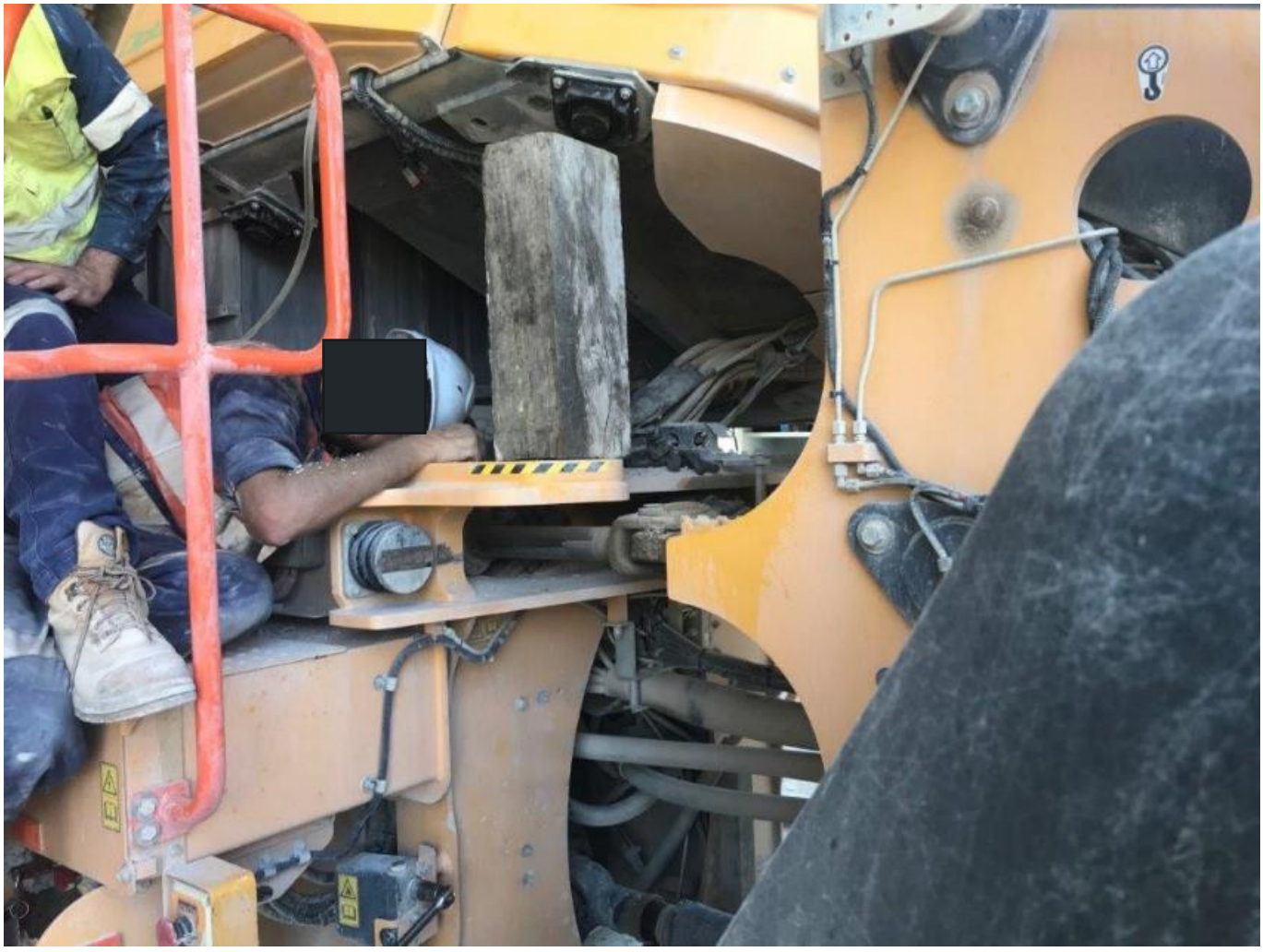
3.6. Likely cause of the unplanned cab descent

The investigation established the following:

1. The float function may initiate other than intended when:
    a. the cab or hydraulic cylinder is bumped just above the height at which the float function initiates; or
    b. through gradual seal leakage of hydraulic fluid
2. The float function of the hydraulic cylinder initiated to cause unplanned descent of the loader cab when it was at a height of:
    a. 300–330 mm above the chassis; or
    b. 310 mm or 340 mm above the chassis and the chassis bumped or rocked.

    NOTE: During post-incident testing the cab was raised to approximately 310 mm or 340 mm and the 'up/down' valve was turned to the 'down' position. The cab remained held in a stable position by the hydraulic ram and did not initiate a descent. However, when the loader was manually shaken by the technician, the cab entered 'float' and self-lowered to the chassis.
3. There was no evidence of gradual seal leakage of hydraulic fluid.
4. On the basis of post-incident testing it is likely that, at the time of the incident, the cab was positioned just above 300 mm or 330 mm when the worker entered the gap between the raised cab and chassis and shook or bumped the cab or hydraulic cylinder causing the float function to initiate and the cab to descend (as established during testing when the cab was shaken).

Figure 6 Recovery scene photograph showing the position of the worker on his side after the cab was raised and a wood chock placed by mine workers following his release from the crush point



4. The investigation

4.1. Activity

The investigation examined the incident including the factors leading up to it, the cause of it and the actions of workers, the contractor and mine operator.

Enquiries made by the investigation team included the issue of 21 notices under section 155 and 2 notices under section 171 of the *Work Health and Safety Act 2011* to give information and provide documents. Five records of interview were conducted during the investigation.

Post-incident testing of the loader by CJD technicians was coordinated and recorded by the investigation team. An external consultant was engaged by the Regulator to assist in understanding the potential risk of injury resulting from the incident, assess the cab tilt mechanism and identify reasonably practicable means or steps available to control the risk.

In addition, the Regulator issued 3 Improvement Notices under section 191, one Prohibition Notice under section 195 and one Non-Disturbance Notice under section 198 of the WHS Act.

5. Investigation findings

5.1. Identified hazard

The investigation established that the design of the cab tilt function gave rise to a crush hazard in that there was potential for a worker to place their torso, head and/or limbs in the 300–330 mm gap

between the loader's cab and chassis in circumstances where the cab may unexpectedly descend without pumping the cab jacking mechanism.

The Regulator's consulting engineer articulated the hazard, following inspection, testing and assessment of the cab tilt function, in the following terms:

> 'The most significant crush risk contributing factor associated with the cab freefall function is the size of the opening between the cab and chassis when freefall initiates which is large enough to allow head (and other large body part) entry into the potential crush space'

5.2. Risk to workers

The investigation further established that the risk to health and safety to which a worker may be exposed as a result of the hazard, whilst not realised on the date of the incident, was serious injury or death:

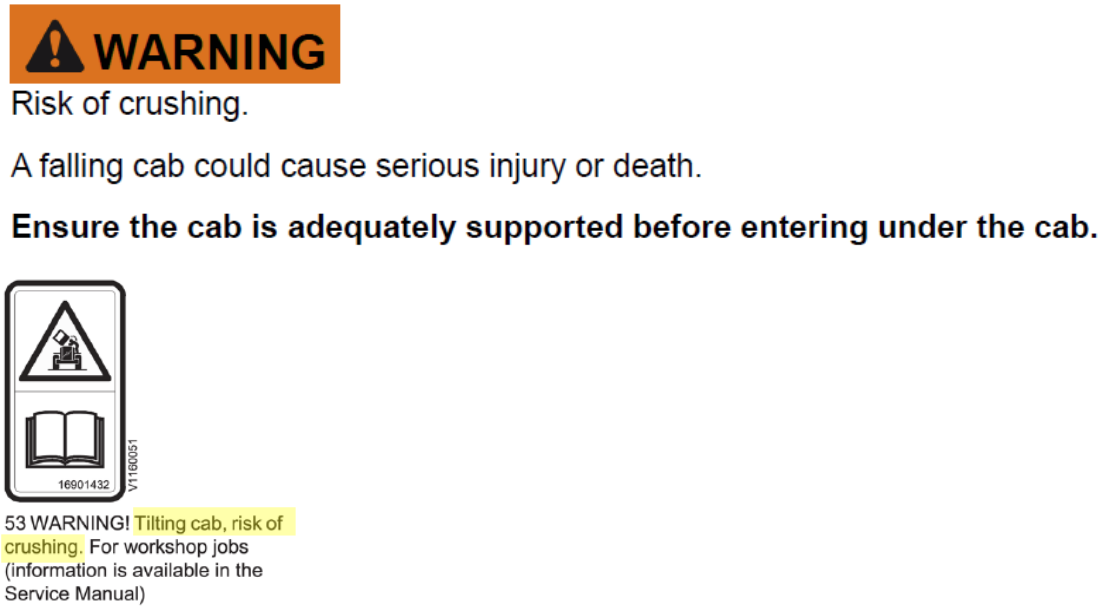
- Warnings incorporated in the OEM procedure provide that 'a falling cab could cause serious injury or death'
- Post-incident testing by the Regulator's consulting engineer established the potential load that could be borne by a person crushed between the cab and chassis as between 5.4 kN (~548 kg) and 7.8 kN (~794 kg) which exceeds the load necessary to fracture a skull (5 kN) or cause thoracic trauma (1 to 3 kN).

5.3. Risk controls

Specific controls directed toward the risk that eventuated during the incident are extracted from the duty holder's safety management systems and canvassed in detail following:

5.3.1. Information warning of a crush hazard

Figure 7 shows the information contained within the Volvo PROSIS Service Manual procedure for both lifting and lowering the cab (highlight added)

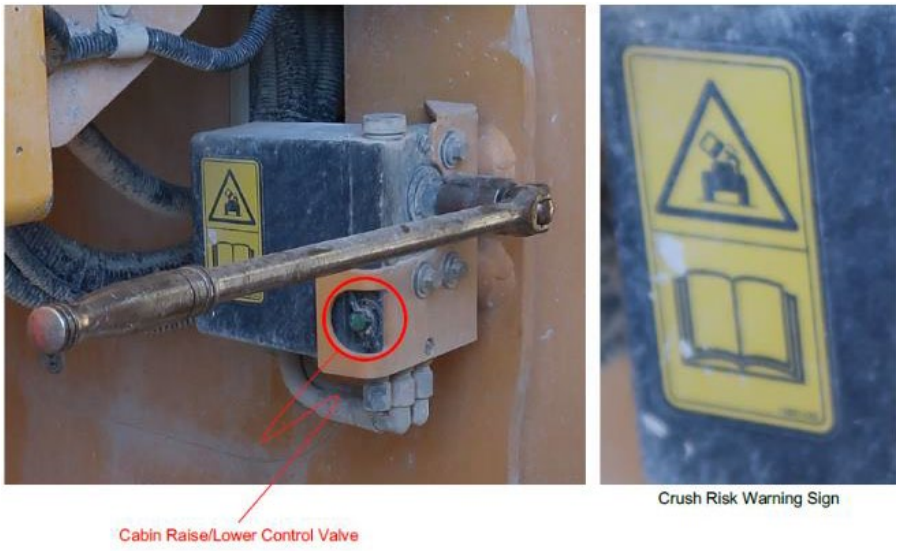


In addition, the first step in the Volvo PROSIS Service Manual procedure for lowering the cab, Cab, position 1, restoring, L220H Volvo, Op nbr 810-067, provides the following:

'Make sure that nothing is trapped or crushed between the cab and frame.'

The following.

Figure 8 shows the information is affixed in a prominent position on the hydraulic pump and handle used by a technician to raise or lower the cab



5.3.2. Information warning of the float function

The following information is contained at step 3 of the Volvo PROSIS Service Manual procedure for lowering the cab, *Cab, position 1, restoring, L220H Volvo, Op nbr 810-067* (emphasis added):

'With approx. *20cm (8 in) remaining*, the cab will lower by itself.

NOTE! Make sure that nothing is trapped or crushed between the cab and frame'.

5.3.3. Graymont job risk assessment

In the job risk assessment (JRA), completed by the worker and endorsed by the maintenance supervisor on the date of the incident, one of the 'risk events' identified by the worker (when both raising and lowering the cab) was 'cab falling' with risk controls identified as 'cab lock' and 'OEM SWP' (a reference to the Volvo PROSIS Service Manual).

In particular, the steps involved in the task were described by the worker in the JSA, extracted as follows:

1. Set up machine
2. Lift cab using machine cab raise pump
3. C/O mounts
4. Lower cab using machine cab lower pump
5. Recommission machine for production

The 'risk events' identified by the worker at step 2 are listed as 'tools', 'falls', 'heat' and, significantly, 'cab falling'. The 'Controls' listed include 'cab lock' and 'OEM SWP'. In the 'Risk events' and 'Controls' sections of step 4 the worker recorded 'Same as raising'.

5.3.4. CJD 'Take 5' risk assessment

The CJD 'Take 5' Risk Assessment, incorporated at the top of the CJD Service Report, is designed to direct workers' attention to the identification of hazards, assessment of risk and implementation of control measures.

On the date of the incident the worker listed hazards as 'energy, tools, falls, COVID, traffic' in the CJD 'Take 5' Risk Assessment but not the cab falling. However, 'JHA' (presumably the Graymont JRA referred to immediately above that did identify 'cab falling' as a hazard) and 'OEM SWP' were listed in the CJD 'Take 5' Risk Assessment as controls.

5.3.5. Information, instruction and training

5.3.5.1. Volvo PROSIS Service Manual

The Volvo PROSIS Service Manual, accessed by the worker on his laptop computer immediately prior to commencing the work task on the date of the incident, includes the following within procedures for both raising and lowering the cab:

- Warnings about the crush hazard associated with a falling cab (refer Section 5.3.1 above)
- Ensure the cab is adequately supported before entering under the cab
- Operation of float function when the cab is approximately 200 mm above the chassis
- Securing the cab with a lock pin when raised to Position 1 (~30˚)

5.3.5.2. CJD online 'Take 5' training

CJD's online 'Take 5' training, completed by the worker on 3 October 2018 and again on 14 October 2020 (1½ months before the incident), provides (inter alia) that a 'Take 5' must be completed when 'a new situation comes up that may not have been considered in the JSA'.

On the date of the incident the worker completed Graymont's JRA, in lieu of CJD's JSA, but this is inconsequential as it does not avoid the worker applying his 'Take 5' training.

5.3.5.3. CJD online induction

The CJD online induction, also completed by the worker on 3 October 2019 and again on 14 October 2020 (1½ months before the incident), provides one of the 'Ten commandments of workplace safety' as:

'Assess the Risks, Stop and Think i.e. NEVER walk under suspended loads.'

5.3.5.4. Sibelco Induction

The Sibelco induction, completed by the worker in October 2018, as a pre-condition to accessing Attunga, lists as a General Environmental, Health and Safety Rule 'ALWAYS reassess and update your risk assessments if conditions or circumstances change and inform your Sibelco representative'.

5.3.5.5. CJD Induction video

A CJD video entitled *Behavioural Safety* shown to workers during CJD's induction process identifies haste as a factor that can contribute to the occurrence of unsafe acts.

5.3.6. Locking pin mandated by Volvo Service Manual

The Volvo PROSIS Service Manual mandates that, when it is raised to position 1, the cab is secured with a lock pin which is a sliding bolt fixed to the frame of the loader that is slid into position under the cab), in addition to support provided by the hydraulic ram to enable safe working between the raised cab and chassis.

5.4. Direct or primary causes of the incident

The investigation established the following as direct or primary causes of the incident:

5.4.1. Unsafe condition

The design of the cab tilt function gave rise to a crush hazard in that there was potential for a worker to place their torso, head and / or limbs in the 300–330 mm gap between the loader's cab and chassis in circumstances where the cab may self-lower with limited retardation and without warning or control.

5.4.2. Unsafe act

The worker positioned his upper body, head and limbs in the gap between the raised cab and chassis that was slightly larger than 300–330 mm, just above the height at which the float function initiates, in the absence of secondary support (in addition to the hydraulic ram).

That is, the worker entered under a suspended load relying upon only the hydraulic ram and without the provision of any secondary support such as a wood block placed to support the cab.

5.5. Ineffective risk controls or causal factors that permitted the direct causes to exist

5.5.1. Inadequate control of access to crush hazard

5.5.1.1. Access by workers to the crush hazard not adequately controlled

The potential for a worker to place their torso, head and / or limbs in the 300–330 mm gap between the loader's cab and chassis, in circumstances where the cab may self-lower with limited retardation and without warning or control, was controlled by lower order (administrative) controls not higher order (engineering) controls.

The lower order (administrative) controls proved inadequate and ineffective as demonstrated by the incident (refer section 5.5.2 'Inadequate information, instruction, training and experience regarding the float function' and section 5.5.3 'Human factors') and reasonably practicable higher order (engineering) controls by means of guarding were not implemented until after the incident (refer section 5.7.1.2 'Addition of barrier(s)').

The NSW Resource Regulator's investigation established the following:

- The Regulator's consultant engineer identified that:

  'The most significant crush risk contributing factor associated with the cab freefall function is the size of the opening between the cab and chassis when freefall initiates which is large enough to allow head (and other large body part) entry into the potential crush space'
- The float function of the hydraulic cylinder initiated when the cab was approximately 300–330 mm above the chassis, or when the cab was slightly higher than 300 mm or 330mm and the cab was bumped, at which time the cab self-lowered with little retardation
- The 300–330 mm gap permitted the head and torso of a worker to be positioned between the cab and chassis when the float function initiated contrary to the following values prescribed by *AS/NZS 4024.1803:2019 Safety of machinery Safety distances and safety gaps — Minimum gaps to prevent crushing of parts of the human body* and the identical international standard *ISO 13854:2017, Safety of Machinery- Minimum gaps to avoid crushing of parts of the human body concerning minimum gaps to avoid crushing of body parts*:
  - 300 mm (head)
  - 120 mm (arm)
  - 100 mm (hand)

5.5.1.2. There is no warning that the float function is about to initiate

There is no visible or audible warning to indicate to a worker that the float function of the hydraulic cylinder was about to initiate or that the cab was approaching the 'float zone'.

While the float function initiates at the same pre-set orientation during each cab lowering function, there is no clear indication that freefall is about to initiate – knowledge of this matter is reliant upon training, experience and vigilance of the operator.

The absence of a warning becomes significant in circumstances where the worker was not otherwise aware of the operation of the float function causing freefall of the cab because of inadequate information, instruction or information and infrequent experience with the system (refer 5.5.2. below).

5.5.2. Inadequate information, instruction, training and experience regarding the float function

5.5.2.1. Overview

The investigation identified that the worker was not provided with adequate information, instruction or training concerning, nor was he otherwise aware of, the float function operation. The worker did not have the requisite experience, necessary to instil knowledge or awareness of the existence of the float function prior to the date of the incident.

There was no visible or audible warning to indicate to the worker that the float function of the hydraulic cylinder was about to initiate or that the cab was approaching the 'float zone'.

5.5.2.2. Inadequate instruction and training

CJD's 'Safe Work Procedures' (February 2020) states, 'Employees of the company shall be trained in the Safe Work Procedures relevant to the work they undertake. It is the responsibility of the Supervisor, in consultation with their Manager to ensure relevant training has been performed and documented.'

The worker was not trained in the safe work procedure for raising and lowering the cab of a Volvo wheel loader and he had never been shown how to conduct the task. The worker described himself as 'self-taught'.

His direct CJD supervisor was unable to provide a reason why the worker was not trained in this specific safe work procedure as required by the OHSMS. His direct supervisor had not discussed the task with the worker nor had he provided any instruction.

5.5.2.3. Inadequate information

The information provided to the worker concerning the procedure for raising or lowering the cab was confined to the Volvo PROSIS Service Manual which included the following within the procedure for lowering the cab (emphasis added):

'With approx. *20 cm (8 in) remaining*, the cab will lower by itself.'

The worker's lack of awareness of the float function, despite the Volvo PROSIS Service Manual including information that the float function initiated freefall of the cab at 200 mm, may be explained on the basis that he had only undertaken the task of raising and lowering the cab on one prior occasion when he worked on a smaller Volvo wheel loader one year prior (9 October 2019) and, accordingly, had only referred to the Volvo PROSIS Service Manual on 2 occasions including the date of the incident.

5.5.2.4. Infrequent experience

The worker did not have the level of experience working with the cab tilt system necessary to be aware that there existed a float function that caused the cab to freefall, in particular at what point (300–330 mm) the float function initiated freefall of the cab.

The worker had only undertaken the task of raising and lowering the cab on one prior occasion when he worked on a smaller Volvo L180H wheel loader one year prior (9 October 2019).

5.5.3. Human factors

In circumstances where ineffective risk controls described in Sections 5.5.1 to 5.5.2 (above) prevailed, and accepting the worker perceived the cable harnesses and hoses were so tight as to require adjustment to raise the cab to position 1 before he ultimately abandoned that approach, the following factors contributed to his exposure to the risk (working under a suspended cab without secondary support).

The worker failed to do the following:

- Risk assess changed circumstances

- Contact the CJD supervisor or Graymont representative when confronted with changed circumstances
- Heed warnings in the Volvo PROSIS Service Manual
- Use a temporary support (e.g. timber chock) to support the suspended cab
- Generally abide by OEM, CJD and Graymont information, instruction and/or training.

In addition, the worker self-imposed time constraints to complete the job as quickly as possible because of several factors:

- It was going to be a hot day
- His first break was approaching
- He wanted to complete the task in a reasonable time
- He was aware that because he couldn't raise the cab to position 1 and use the lock pin it became a serious safety issue, however, he was in a rush and decided to continue on with the task.

Although it was not directly related to the cause of the incident, contrary to CJD remote worker procedures, the worker left his 'SPOT Gen3 emergency beacon' in his work truck instead of wearing it on his person whilst he was working alone at the time of the incident. This had the potential to delay his rescue had mine workers not been located nearby.

5.6. Post-incident remedial measures

5.6.1. CJD

CJD implemented the following post-incident remedial measures:

1. Issued a Safety Directive prohibiting any employee from working under a tilted cab without the locking pin in place
2. Issued a Safety Alert to staff describing the risks and preventative actions in relation to the incident
3. Added a check criteria to the 'Plant Assessor Risk Management Survey' which guides pre-delivery inspections of mobile plant, verifying the cab can be tilted and locked at position 1 without requiring intervention
4. Initiated a program requiring service personnel to carry out a check of mobile plant delivered to customers verifying the cab can be tilted and locked at position 1 without requiring intervention – as of 19 February 2021, 45 machines had been checked with no rectification required
5. Released a document entitled 'Positioning of aftermarket cable harnesses / hoses below the floor of the operator's cab 'H' series WLO with tilting cab' that provides instructions for routing of aftermarket wiring, harnesses / hoses between the plants cab and chassis
6. Developed a mobile audit process on the 'iAuditor' platform (mobile phone application) requiring Service Supervisors to undertake unannounced audits on field service technicians including verification of a completed JSA and technician referencing the Volvo PROSIS Service Manual
7. Provided additional training to workers including a training module concerning the procedure for raising and lowering tilted cabs (delivered to all personnel as part of the Rapid Global Training System) and a second JSA training module uploaded to the CJD technicians' online training system
8. Implemented intensive one-on-one face-to-face supervision of the worker by a senior staff member temporarily relocating to Tamworth with daily outcomes communicated through to CJD's National HSE unit. CJD also conducted Microsoft Teams virtual refresher training with National HSE and the worker concerning JSAs
9. Refer section 5.7 following concerning engineering (guarding) controls.

5.6.2. Graymont

Graymont implemented the following post-incident remedial measures:

1. Undertook the following to ensure all contractors attending the Attunga site were provided appropriate information, training, instruction and supervision:
    a. Reviewed and implemented an online induction.
    b. Reviewed a site-specific key risk statement.
    c. Installed a security gate to prevent unauthorised access.
    d. Reinforced requirements for safety contacts.
    e. Assigned a supervisor to contractors working on site.
2. Undertook the following to mitigate additional risk arising from lone work:
    a. Stopped work from being conducted that would constitute working alone and/or ensured at least two people were on shift together at any one time supported by an overarching policy identifying the risk and controls.
    b. Obtained a quote for a camera to be installed at the heavy vehicle maintenance bay with plans to implement real time monitoring by the weighbridge/administrative staff.
    c. Reviewed the Working Alone Policy and reassessed potential working alone areas/situations to consider introducing additional mitigation and control measures to further reduce risk.
3. Reviewed and updated documents in its SMS, removing any documents that were outdated, with re-branding from Sibelco to Graymont substantially complete. A gap analysis of existing SMS elements in comparison to the Graymont Safety Standards was also completed.
4. Made changes to the following policies and procedures:
    d. Working alone policy: An initial review and a site-specific risk assessment of the policy was conducted to inform specific changes required to capture additional site-specific locations, tasks or situations with a potential working alone risk.
    e. Contractor management policy: The policy was reviewed with a focus on induction, supervision and a process to capture more clearly in writing which SMS, or elements thereof, under which a contractor works.
    f. Quick Risk Check (Take 5, Last Minute Risk Assessment): This process was updated to include working alone.
    g. Contractor management: A global initiative was initiated to explore options for an IT system supporting contractor management which could record information such as verification of qualifications, tickets and insurances.
    h. Contractor Gap Analysis: An analysis was conducted to identify any gaps in the currency of contractor induction against Graymont's preferred currency period (12 months) and immediately address them together with a process for ongoing checking and maintenance of currency into the future.
    i. Supervision and oversight:
        i. Incorporation of an agreed check-in period (control) as part of a risk assessment in the case of lone working or work in a busy area.
        ii. (in preparation for the installation of cameras) Development of a process to ensure weighbridge/administrative staff are informed when someone was working in circumstances requiring additional monitoring by video.
5. Conducted a number of safety presentations regarding the incident and associated learnings and conducted toolbox meetings with site employees and contractors at Attunga and other Graymont operations to explain and discuss the incident, causal factors and appropriate

controls. A demonstration of the cab tilt function, its safety controls and contributing factors to the incident was carried out with relevant Attunga staff and contractors.

5.7. Reasonably practicable steps to mitigate the risk arising from the crush hazard

5.7.1. Controls proposed by CJD and Volvo Construction Equipment AB

CJD and Volvo Construction Equipment AB considered several possible solutions to reduce the opening between the cab and the chassis of the Volvo L220H loader to meet the directions imposed by the Regulator's improvement notice of 27 August 2021. That is, to bring Volvo L220H loaders into compliance with the OEM specifications whereby the cab freefall or self-lowering (float) function initiates when the cab is positioned approximately 200 mm above the chassis.

5.7.1.1. Redesign cab tilt hydraulic cylinder

CJD and Volvo Construction Equipment AB identified that the float gap could not be reduced by modifying the cab tilt hydraulic cylinder design, as the dimensions of the current cylinder were required in order to allow the cab sufficient movement in rough operating conditions.

In addition, reducing the length of the free float port inside the hydraulic cylinder was not possible as this would lead to an unacceptable risk of piston seal damage.

CJD and Volvo Construction Equipment AB identified that it was not reasonably practicable to mitigate the crush risk through engineering modifications to the hydraulic cylinder.

5.7.1.2. Addition of barrier(s)

CJD and Volvo Construction Equipment AB proposed the addition of a 75 mm-high polyethylene barrier fixed to the chassis to reduce the gap between the cab and the chassis to approximately 200 mm at the point where the cylinder enters its free fall.

NOTE: This calculation is based on Volvo's assumed measurement of a current float gap of 270 mm but, based upon measurements made during post-incident testing, the modified float gap would actually be 225–255 mm

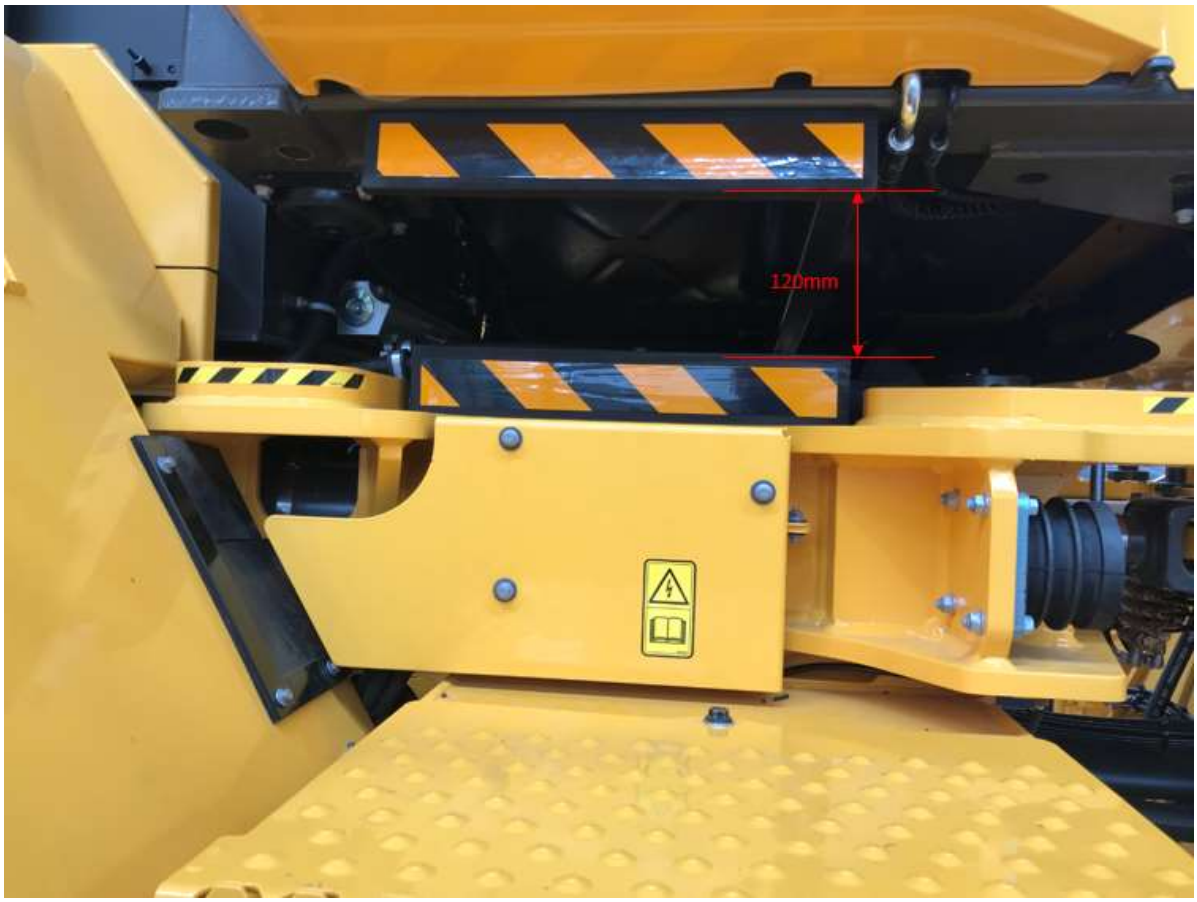
The barrier is retrofittable on existing and new machines and would be inspected by CJD or other service technicians as part of the list of standard checks conducted on the machine prior to and during supply.

A warning decal stating, 'Do not remove the barrier' and other decals relating to the risks posed by the cab tilt function would also be added to the machine.

After their initial response to the improvement notice of 27 August 2021, CJD proposed to fit an additional barrier to the underside of the cab main frame to significantly reduce the opening as the cab lift cylinder enters its float position. This second barrier was proposed to be fitted in addition to the barrier fixed to the loader's chassis. According to CJD, fitment of the two barriers would reduce the gap between the cab and the chassis to approximately 120 mm in the position where the cab enters its free fall.

NOTE: This calculation is based on Volvo's assumed measurement of a current float gap of 270 mm but based on measurements made by CJD during post-incident testing, the modified float gap would actually be 145–175 mm.

Figure 9 CJD-supplied photograph of two barriers fitted to the underside of a Volvo loader cab to reduce the float gap



5.7.1.3. Removal of the cab tilt cylinder

CJD and Volvo Construction Equipment AB advised the tilt cylinder could be removed completely thereby rendering the tilted cab system redundant.

This option would, however, necessitate the use of a crane and other lifting equipment in order to conduct work under the loader cab thereby introducing additional risk.

6. Recommendations

It is recommended that:

6. **Manufacturers, designers, importers and suppliers of mobile plant** used at a workplace must, so far as is reasonably practicable, develop and implement safe systems of work (including procedures) directed toward:
    j. assessing health and safety risks including those arising when mobile plant is used in a way not intended by the designer as a result of reasonably foreseeable or predictable worker behaviour such as:
        iii. taking the 'line of least resistance' or self-imposing time constraints when carrying out a work task, to reduce time and effort, that may compromise safety
        iv. not complying with procedural requirements
        v. working without adequate information, instruction, training and / or experience
        vi. reacting to a real or perceived business requirement to keep mobile plant operational.
    k. applying the hierarchy of controls to eliminate or minimise health and safety risk that may arise including (but not limited to) risk arising from:
        vii. suspended loads

viii. crush hazards

ix. infrequent work tasks such as inspection, servicing, maintenance and repair

x. reasonably foreseeable or predictable worker behaviour such as that set out at 1.a (above).

l. ensuring that when eliminating or minimising health and safety risk arising from work around crush hazards and/or under suspended loads:

xi. Mechanisms that hold a suspended load at any position in the cycle of opening or closing are designed to be inherently safe between the closed and open positions where a person can be positioned under the suspended load.

xii. A suspended load will not release from a position that appears to be stable without the operation of controls.

xiii. Consideration should be given to geometrical factors relating to crush hazards by increasing the minimum gap between moving parts or by reducing the gap to prevent entry of parts of the body.

xiv. Administrative controls, such as procedures and information or warnings in OEM manuals, are not solely relied upon to control risks to health and safety where the implementation of engineering controls to further reduce the risks are reasonably practicable.

NOTE: Duties of manufacturers, designers, importers and suppliers also apply if the original design is changed or modified.

m. carrying out, or arranging the carrying out of, calculations, analysis, testing or examination necessary to achieve 1.a to c. (above) including (but not limited to) verifying that risk controls, such as engineering controls, operate pursuant to OEM specifications.

NOTE: Where a principal designer of mobile plant sub-contracts the design of systems or components and supplies the subcontracted designs, the principal designer must carry out any calculations, analysis, testing or examination that may be necessary to verify that engineering controls operate pursuant to OEM specifications.

n. giving adequate information to each person to whom the mobile plant is provided concerning:

xv. the results of the matters set out at 1.d (above)

xvi. conditions necessary to ensure the mobile plant is without risks to health and safety when used for a purpose for which it was designed or manufactured or when carrying out any activity (including inspection, servicing, maintenance or repair).

7. **Duty holders whose business or undertaking involves inspection, servicing, maintenance and repair of mobile plant** review their health and safety management plan to ensure it provides safe systems of work directed toward:

o. eliminating or minimising health and safety risk arising from:

xvii. work under suspended loads, around crush hazards and lone work

xviii. infrequent work tasks such as inspection, servicing, maintenance and repair

xix. reasonably foreseeable or predictable worker behaviour such as that set out at 1.a (above).

p. information, instruction and training competency programmes that incorporate:

xx. role-based training needs analysis to identify role-specific core competencies, risks to health and safety arising from work performed (incl. those listed at 2.a.i. above) and information, instruction, training and experience necessary to develop role-specific core competencies

xxi. development and execution of a training plan to address matters identified at 2.b.i. (above) including structured, formal and comprehensive information, instruction and

training (beyond the mere reading of OEM manuals) where identified by a case-by-case risk-based assessment

NOTE: Ad-hoc unstructured information, instruction and training, including the mere reading of OEM manuals, may be adequate in the case of risks to health and safety that are low but not those that are moderate to high i.e. the level of structure, formality and comprehensiveness of information, instruction and training increases with the level of health and safety risk

xxii. transparent and accountable means of monitoring implementation of training plans through to finality.

q. means of verifying worker compliance with procedures and application of information, instruction and training concerning work under suspended loads, around crush hazards and lone work.

8. **Workers** who perform work under suspended loads or around crush hazards associated with mobile plant or lone work:

r. Take reasonable care for their own health and safety by:

xxiii. not entering under a suspended load without a secondary support device in place

xxiv. not working around uncontrolled crush hazards

xxv. complying with procedures to control risks to health and safety arising from lone work.

s. Comply with any reasonable instruction and co-operate with any reasonable policy or procedure imposed by another duty holder directed toward:

xxvi. controlling those risks

xxvii. assessing changed circumstances that may impact upon the effectiveness controls to eliminate or minimise risks to health and safety

xxviii. suspending work and contacting a supervisor when confronted with changed circumstances to establish risk controls necessary for work to proceed safely.

9. It is recommended that **mine operators** review and monitor implementation of a contractor health and safety management plan by:

t. verifying contractor compliance with site rules whilst working under suspended loads and around crush hazards associated with mobile plant

monitoring, including conducting safety observations, of contractors working alone.