Mines Safety Bulletin No. 110

Subject: Seeking safe mobile autonomous equipment systems

Date: 14 March 2014

Summary of hazard

With the introduction of mobile autonomous and semi-autonomous vehicles on some Western Australian mine sites, hazards have emerged that must be considered and managed.

Significant incidents involving autonomous mobile equipment over the past few years in Australia and overseas include:

- an autonomous haul truck reversing over a waste dump windrow during an autonomous edge-dumping operation
- a water truck colliding with an autonomous truck at an intersection after the autonomous system had identified the collision potential and the autonomous truck had stopped
- a blast hole autonomous drill rig reversing into the rear of a stationary blast hole drill rig while in remote control
- a grader colliding with an autonomous truck when the grader pulled out at an intersection
- an autonomous truck backing over an edge that had been undercut.

Fortunately, no-one was injured in these incidents but consequences could have been more serious.

Contributory factors

Investigations into these incidents have identified a number of contributing factors, including:

- specification and design of safety systems
  - detection systems not included in design
  - detection systems only monitoring forward motion
  - users remotely overriding safety systems
- human factor issues
  - failure to respond appropriately to system information or warnings
  - misinterpretation of system information or ignoring warnings
  - lack of system knowledge and understanding of how the autonomous equipment system works
  - not adhering to personnel or equipment exclusion zones
- process issues
  - personnel in active areas without having appropriate communication devices

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- visual inspections, verification and audits failing to identify deviations
- information not displayed or unreadable.

Actions required

These incidents highlight the importance of ongoing comprehensive risk management activities that include:

- completion of structured hazard identification
- detailed risk assessments
- validation of employee training and competency
- provision of adequate supervision

when introducing autonomous or semi-autonomous mining technologies or systems.

Each employer at an autonomous mine has a duty of care to ensure processes and controls are adequately designed and implemented to minimise the risk of injury or harm to all workers on site.

Section 9 of the *Mines Safety and Inspection Act 1994* requires a safe system of work to be developed for mining operations. The following measures are recommended for autonomous mobile equipment operations.

- Design all equipment to:
  - be fit-for-purpose
  - comply with relevant standards, with layers of protection that recognise the potential for human error
  - provide effective warnings
  - detect critical issues and stop the system through fail-safe systems.

  Consider the hierarchy of control and use elimination or substitution where possible to address hazards. Should engineering controls be necessary, robust systems and processes need to be developed to support operational use.

- Rigorously test structured programs that verify critical system safety features and associated procedural processes.

  Pre-deployment testing and user acceptance testing cover scenarios where safety critical components are tested and fail-safe measures verified.

- Develop and deliver comprehensive training and assessment programs to ensure personnel are competent to undertake assigned tasks.

  Competent and authorised personnel undertake task observations to check compliance with training standards and operating procedures.

- Implement strict authorisation and access controls to maintain and ensure area security.

  Set-up, delineate and validate exclusion zones before any work takes place in an autonomous mine.

- Formally describe and document processes for re-starting any autonomous mobile equipment that stops due to the system detecting a hazard.

Implement comprehensive protocols that allow any issues to be investigated, diagnosed and verified before re-starting any autonomous mobile equipment.

- Conduct regular inspections and audits to ensure the integrity of system data and suitability of the operational environment for autonomous mobile equipment.

  Competent and authorised personnel undertake rigorous operational reviews of the autonomous mine to check that the recommendations of previous reviews have been actioned, confirm that appropriate responses have been made to any incidents or issues arising, verify compliance with specifications, validate the continued use of the autonomous system, and identify any system or operational defects. A record of review outcomes should be maintained by the mine operator, including any actions recommended and details of how they were addressed or implemented.

- Implement a change management process when any part of the autonomous system is updated or amended.

  Competent and authorised personnel undertake rigorous assessment of the impact of changes and ensure effective controls are in place.

- Develop detailed emergency response procedures to allow operational personnel to effectively communicate and suspend operations should they detect an issue.

  All operational personnel working within the autonomous mine have access to and are trained in the use of suitable communication and emergency devices.

Further information

Visit www.dmp.wa.gov.au/ResourcesSafety for information on occupational safety and health in the resources sector.

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