

Mines Safety Bulletin 139

Risk management of high pressure fluids and gases

Background

The risk of serious injury resulting from the uncontrolled release of high pressure hydraulic fluids is of ongoing concern. There have been two recent incidents reported over the Christmas period of 2013, with a number of other incidents during 2013. Fortunately none have resulted in serious injury. High pressure hydraulic fluid injection injuries also can be difficult to recognise, prompting the Inspectorate to again focus attention on this hazard. This Safety Bulletin covers risk management of high pressure fluid within the safety and health management system, including emergency response and should be read in conjunction with Safety Bulletin 67, Managing high pressure fluids and gases.

Information on specific mining incident, including fatalities

Since Safety Bulletin 67 was issued in 2007, there have been several high pressure fluid incidents in Queensland coal mines, the majority involving hydraulic fluids. Safety Alerts on high pressure fluids, including exposure to chemicals under high pressure, were issued in 2008, 2010 and 2011:

- Safety Alert 271 Longwall fluid injection injury – A coal mine worker was struck by an uncapped hose connected to a PTO port.
- Safety Alert 286 Coal Mine Worker hit by loose discharge hose – The coal mine worker was hit by an unrestrained hose when the pump pressure relieved while he was conducting an inspection on the pump cart.
- Safety Alert 196 Mine Worker Suffers Chemical Burns to Eyes due to High Pressure Fluid Release - A coal mine worker received facial injuries and chemical burns to his eyes as a result of the uncontrolled release of diluted foam catalyst from a pressurised line.

In NSW, Safety Bulletin 13-01 Fluid injections result in surgery, was released after three serious accidents in 2013 resulted in workers undergoing surgery and significant rehabilitation. As the NSW underground coal sector had two previous fatal incidents in 1991 and 2006 involving high pressure fluid from longwall mining equipment, extensive information is available from Mine Safety NSW, <http://www.resources.nsw.gov.au/safety>.

Some of this information includes data analysis, presentations and MDG 41: Guideline for Fluid Power System Safety at Mines. NSW Mine Safety issued Safety Alerts/Bulletins SA04-14, SA05-15, SA06-16, SA06-18 and SB12-03 on high pressure fluid incidents.

Overview of the hazard

The hazard is

- the uncontrolled release of high pressure hydraulic fluid that can potentially come into contact with a worker, or

- failure to isolate uncontrolled energy.

A NSW Mine Safety review of incidents between 2007 and 2010¹ identified the most common location and source of high pressure fluids and gases that lead to fluid injection. The location is in underground coal at the longwall face and involving hoses of longwall

equipment, followed by development units, then equipment outbye.

Surface and open cut incidents were less frequent, but still had potential to cause serious injury.

The NSW review also concluded the most common known failure mechanisms were hose failures, followed by unsafe isolation, fitting failures, then unplanned movement of equipment/plant.

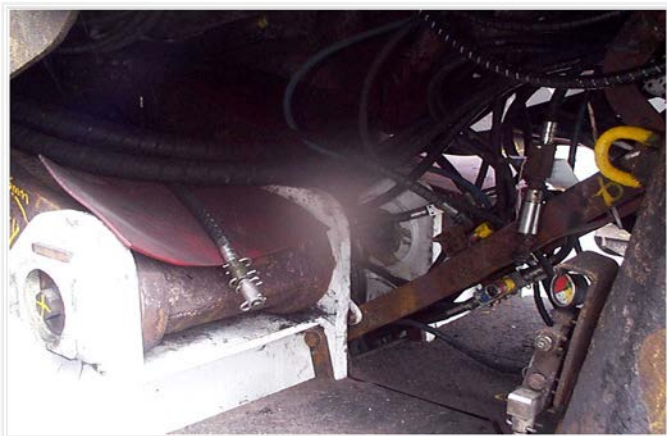


Image 1: Longwall PTO port



Image 2: Worn out or corroded hose braiding

(image 1 and 2 from the 2003 NSW Mechanical Engineering Presentation on Hydraulic Safety available from http://www.resources.nsw.gov.au/_data/assets/pdf_file/0003/84504/FIPresentation.pdf)

Compressed air jets, diesel fuel injectors, paint sprayers and high pressure hydraulic systems are only a few examples of high pressure fluid or gas sources, all potentially able to contact the skin and cause tissue damage.

Legislation requires risk management of high pressure fluid

All Queensland mines must recognise the hazards associated with high pressure fluids and gases, and manage these hazards appropriately, as per section 29 of the *Coal Mining Safety and Health Act 1999* (CMSHA) or section 27 of the *Mining and Quarrying Safety and Health Act 1999* (MQHSA), to achieve an acceptable level of risk. Management and operating systems must meet the requirements of s30, CMSHA (or s27, MQHSA) incorporating risk management principles and elements.

In addition, management of fluid and gas under pressure is specifically covered by:

- the *Coal Mining Safety and Health Regulation 2001*, s80 Fluid above and below atmospheric pressure, and
- the *Mining and Quarrying Safety and Health Regulation 2001*, Part 10 Plant generally.

Key components of a risk management plan for high pressure fluids or gases

A mine's safety and health management system needs to identify all aspects of safely managing a high pressure fluid system as well as the emergency response, including treatment of any injuries that may result from interaction with the system.

The severity of these injuries has been known to be underestimated. Therefore sites should consider the minimum expected

outcome of a suspected high pressure fluid injection injury will be hospital admission.

Risk management elements – High pressure fluid systems

a. Safe purchasing/design and replacement

When selecting new or replacement machinery, or when machinery undergoes overhaul or refurbishment, consider engineering or design controls which reduce the hazards from an uncontrolled release of energy.

b. Risk assessment

Risk assessment should incorporate, at a minimum:

- All relevant Safety Bulletins or Safety Alerts or other alerts
- NSW MDG 41 Guideline for Fluid Power System Safety at Mines
- Information from suppliers, manufacturers, and original equipment manufacturers (OEMs).
- Available sources of good practice, including examples from mines who have shared their systems. Some sources are included on page 5 of this bulletin.

c. Risk control measures, considering the hierarchy of controls

Isolation

Isolation processes ensure high pressure systems are effectively depressurised to ensure all potential energy sources are neutralised.

Engineering

- provision of anti-whip socks/sleeves
- segregation plates or barriers, and
- anti-abrasion/ diffusion covers (below)



Image 3: Anti-abrasion/diffusion cover *Photo from MMG century mine innovation award (2011) – See further information.*

Administrative controls

- adopt a whole-of-life cycle strategy for the fluid power system components
- conduct regular and effective inspections of all components of the fluid pressure system, particularly those areas subject to wear and tear

Mitigation: Post incident

Some Queensland sites are using tell-tale additives, which fluoresce under ultraviolet light, in their hydraulic fluids. These can help identify the extent and severity of the injury.

d. Effective monitoring and review

Based on manufacturers' specifications, the safety and health management system should allow for the traceability of hydraulic hoses through their operational life.

Review maintenance practices, whenever changes in hoses or systems occur, to maintain the whole-of-life cycle strategy.

e. Competencies

Although neither the Queensland Coal Mining Safety and Health Advisory Committee or the Mining Safety and Health Advisory Committee have yet

recognised related competencies, the NSW MDG 41 is a good basis for training those who may be required to interact with high pressure hydraulic systems.

Also consider the competencies required by the emergency response team and medical support to identify the presence of a high pressure fluid injection injury and ensure that correct protocols are followed.

f. Emergency response, including medical treatment

The minesite must recognise that emergency response for a suspected fluid injection injury must be fast and coordinated, and that the injured worker needs to be evaluated as soon as possible by a medical practitioner with expertise in the diagnosis and treatment of these injuries.

MDG 41 contains a sample Fluid Injection Protocol (Appendix E, Section 9.5) that can form the basis of a protocol for Queensland Mines. As the protocol has specific information on appropriate hospitals in NSW for treatment, but not Queensland, the site will need to determine their closest available facility for treatment. This can be done in conjunction with the site Nominated Medical Advisor if they have the appropriate skills in managing these injuries.

The protocol should highlight that these injuries may result in the amputation of the affected limb or body part, cause significant health effects requiring intensive care, or could cause death if not appropriately treated.

Sites should also review their protocols on a regular basis as their emergency personnel change, or new personnel commence. There are three key points for Queensland mines that should be considered in conjunction with the protocol found in MDG 41:

1. The site needs to ensure they have appropriate information on the seriousness of these injuries for all workers.
2. Emergency response personnel require appropriate training on initial recognition and treatment.
3. The site needs to have clear protocols for emergency evacuation by ambulance or air, and the ability to trigger them quickly.

Protocol summary (adapted from MDG 41, Appendix E)

- Treat all possible fluid injection injuries as extremely serious or life threatening.
- Train site First Aiders in the appropriate response and treatment strategies.
- Identify the closest medical facility with expertise in diagnosis and treatment of these injuries. This will require contact with your local hospital and/or Nominated Medical Advisor to identify where the expertise is available.
- Currently hospitals with appropriate hand surgical facilities in Queensland include the Princess Alexandra Hospital and the Royal Brisbane Hospital.
- The injured person should be referred to the appropriate hospital as a matter of urgency.
- Have systems in place to provide emergency transport to hospitals equipped and capable of adequately treating the injury type.
- Provide the attending medical professionals or institutions with Material Safety Data Sheets (MSDS) relating to the product suspected of being injected.
- Provide the medical facility that will be treating the patient with documentation that describes the time, date, circumstances and symptoms that have been observed while at site..

Further Information

1. Overall site risk management
 - NSW Department of Primary Industries' MDG 41 - "Guideline for Fluid Power System Safety at Mines" should be considered as a valuable reference tool.
 - Xstrata Coal (2007) SIRFT Presentation, Hydraulic Risk Management provides some information on common areas of concern, and is available from http://www.sirft.com.au/wikis/imrt/images/6/6b/Hydraulic_Presentation_Xstrata.pdf
2. Engineering control measures- examples from Qld Mining Safety and Health Innovation awards
 - QRC (2011) Fluid Injection Protection – 700 Bar Twin-Hose Line, presented by Century MMG. Available at http://www.qrc.org.au/conference/_dbase_upl/Fluid%20InjecProtecHose.pdf
 - QRC (2010) Kevlar Whip Restraints, presented by Anglo Coal, Moranbah North Underground Coal Mine. Available at http://www.qrc.org.au/conference/_dbase_upl/Kevlar%20Whip%20Restraints%20Moranbah%20north.pdf
3. Mitigation - Fluid fluorescent additives for high pressure fluids for hose breakdown and post injury detection
 - FluidSafe (2013) Presentation on use and benefits of FluidSafe patented oil additive. Presentation and product available from T & T Global Solutions, info@fluidsafe.com.au , or from Mackay Mines Inspectorate
4. Worker education or toolbox- general fluid injection injury description with pictures
 - <http://www.youtube.com/watch?v=KqtqCUF1E5A>
5. Information for medical or health professionals, including site paramedics
 - Bourget, DM and Perrone, J (2011) High-Pressure Decisions: Recognition and Management of Uncommon Hand Injuries, *J. Med. Toxicol* 7:162–163, from http://download.springer.com/static/pdf/90/art%253A10.1007%252Fs13181-010-0122-6.pdf?auth66=1389330902_8a667c666a8a75198df623f748d2d0d6&ext=.pdf
 - Choi YH, Cho KH, Lee HM, Lee DH, Yun SY (2011) X-ray quiz: a man with finger pain, *Hong Kong J Emerg Med*, 18, 6, p 446-448 available at <http://hkcm.com/html/publications/Journal/2011-6%20November/p446-448.pdf>
 - Medscape (2013) High-Pressure Hand Injury Clinical Presentation, accessed at <http://emedicine.medscape.com/article/826620-clinical>
6. Other case study information for discussion
 - Mining Accident News No.1312, Jan 2014 *UK: Brave dad survives Doncaster mining accident*, p 16- 17, available by emailing themarkfreeman@gmail.com

References

1. New South Wales Department of Primary Industries (2011). NSW Coal Mines High Pressure Hydraulics Incident Analysis Review of Incidents from January 2007 to December 2010 under the CMH&S Regulation 2006. Presented to the MEMMES Seminar - April 2011 – Paul Drain, Inspector Mechanical Engineering available at http://www.resources.nsw.gov.au/_data/assets/pdf_file/0008/389843/High-pressure-hydraulics-incident-analysis-presentation-.pdf
2. New South Wales Department of Primary Industries (2010). Guideline for Fluid Power System Safety at Mines: MDG 41 available at http://www.resources.nsw.gov.au/_data/assets/pdf_file/0008/419489/MDG-41.pdf
3. Marley, J, (2012), A Brief Review of Fluid Power System Safety in Australia. *J Health and Safety Research and Practice*, 4(2), 22-32.

