



Significant Incident Report No. 229

Subject: Worker injured using high-pressure water jetting equipment

Date: 18 November 2015

Summary of incident

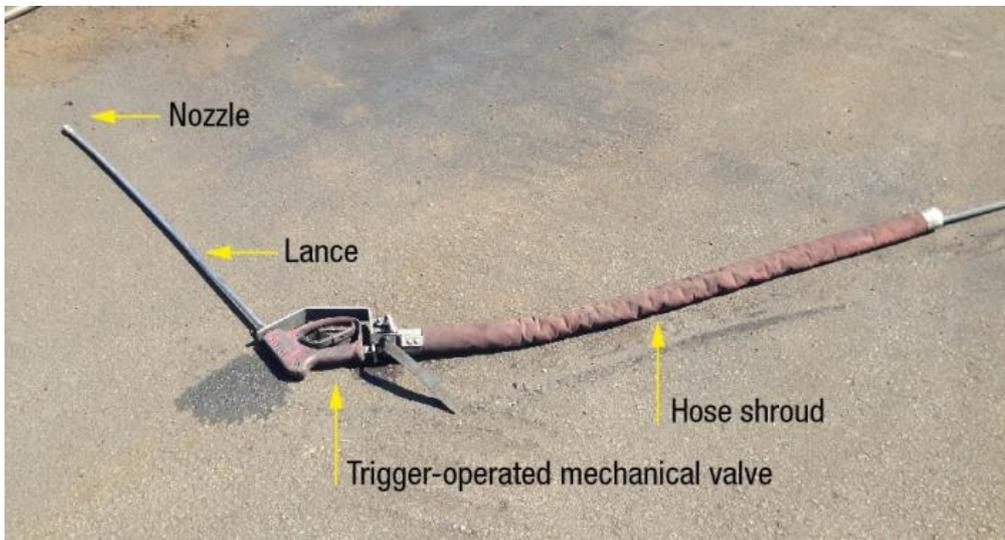
A worker in a confined space was cleaning demister pads using high-pressure water jetting equipment (jetting gun, lance and pencil nozzle supplied by a water-jetting pump). The worker had taped a torch to the end of the lance because the workspace was dark with poor visibility due to the dispersion of water and particles from the cleaning process.

The worker stood upright, holding the high-pressure water lance between his legs, with the lance facing down and at 90° to the demister pads. The jet of high-pressure water struck his protective gum boot while cleaning the pads.

The force of the water was sufficient to pass through the lining of the boot and penetrate the worker's foot, creating a high-pressure injection wound that entered and exited through the inner ball of his foot.



Entry point where high-pressure water jet penetrated boot lining



Example of high-pressure water jetting equipment

Direct causes

- The operating pressure of the water jet greatly exceeded the pressure rating of the protective gum boot worn by the worker.
- The worker pointed the nozzle directly down, within the vicinity of his feet.

Contributory causes

- The pressure setting and water flow rate used during cleaning resulted in twice the recommended reaction force.

Note: A reaction force is created as water leaves the nozzle. This force acts in the opposite direction to the water flow. Exceeding the reaction force makes it more difficult for an operator to control the direction of the water jet.

- Personal protective clothing and footwear capable of withstanding the force of the water jet was not worn.
- The torch attached to the lance partially obscured the worker's vision of the nozzle head and working area.
- There was insufficient lighting for the work task and environment. Intrinsically safe lighting available at the workplace was not utilised.

Actions required

The following actions are recommended to help reduce the potential for injuries when using high-pressure water jetting equipment.

Risk assessment

- Prior to any high-pressure water jetting operations, conduct a suitable risk assessment for the proposed work task. Consider the nozzle type, maximum operating pressure of the pump, type of equipment and water flow rate to be used.

Reaction force

- Calculate the reaction force using the high-pressure water jetting pump's maximum pressure rating and nozzle charts supplied by the manufacturer.

- Use the calculations to confirm that the reaction force when operating the jetting gun will be equal to or less than the maximum reaction force of 250 N or 25.5 kg, as specified in Safe Work Australia's *Guide for managing risks from high-pressure water jetting*.

Note: When a reaction force greater than 250 N or 25.5 kg is required to achieve acceptable results, use mechanical devices to control the nozzle (e.g. mechanised equipment or engineered structures designed to hold the excess reaction force in all planes).

Protective footwear and clothing

- Workers should wear protective footwear complying with Australian Standard AS/NZS 2210.3 *Occupational protective footwear – Specification for safety footwear*.
- Where there is a risk of injury, personal protective equipment (PPE) should include:
 - a foot and lower leg guard or shield
 - leg and body armour
 - protective gloves, face shield and eye protection.

These should be made of materials capable of withstanding the direct force of the water jet.

Note: Always wear suitable PPE regardless of the other control measures in place.

- Workers should wear waterproof protective clothing complying with:

AS/NZS ISO 6529 Protective clothing – Protection against chemicals – Determination of resistance of protective clothing materials to permeation by liquids and gases

AS/NZS 4503.2 Protective clothing – Protection against liquid chemicals – Test method: Determination of resistance to penetration by a jet of liquid (jet test)

AS/NZS 4503.3 Protective clothing – Protection against liquid chemicals – Test method: Determination of resistance to penetration by spray (spray test).



Personal protective equipment. Left: Worker using high-pressure water jetting equipment while wearing appropriate face shield, blast suit, protective gloves, and boots with covering foot shield. Right: Protective boot and covering foot shield.

Workers and the environment

- Workers operating high-pressure water equipment should direct the water jet away from their body at all times.
- There should be sufficient lighting provided to the working environment.

Further information

Guide and standards

- Safe Work Australia, www.safeworkaustralia.gov.au

Guide for managing risks from high pressure water jetting (2013)

- Standards Australia, www.standards.org.au

AS/NZS 2210.1 Safety, protective and occupational footwear – Guide to selection, care and use

AS/NZS 2210.3 Occupational protective footwear – Specification for safety footwear

AS/NZS ISO 6529 Protective clothing – Protection against chemicals – Determination of resistance of protective clothing materials to permeation by liquids and gases

AS/NZS 4503.2 Protective clothing – Protection against liquid chemicals – Test method: Determination of resistance to penetration by a jet of liquid (jet test)

AS/NZS 4503.3 Protective clothing – Protection against liquid chemicals – Test method: Determination of resistance to penetration by spray (spray test)

AS/NZS 4233.1 High pressure water jetting systems – Safe operation and maintenance

AS/NZS 4233.2 High pressure water jetting systems – Construction and performance

AS 3791 Hydraulic hose

AS/NZS 1680.1 Interior workplace lighting – General principles and recommendations

High-pressure injection injuries

High-pressure injection injuries are serious with the potential to threaten life and limb. The combination of irritant material and high pressure can lead to extensive inflammatory reaction, vascular compression and local necrosis.

Note: The pressure required to penetrate the surface of skin is about $7 \times 10^5 \text{ N/m}^2$ or 100 psi

This Significant Incident Report was approved for release by the State Mining Engineer on 18 November 2015