



Mines Safety Significant Incident Report No. 170

Gold room explosion – integrated pressure strip electrowinning (IPSE) circuit failure

Summary of incident

A pressure vessel containing one of the electrowinning cells of an integrated pressure strip electrowinning (IPSE) circuit catastrophically failed during a gold stripping process. The lid of one of the pressure vessels was blown off after the 24 holding bolts were broken or their threads stripped. The heavy lid, weighing about 500 kg, punched a hole in the gold room roof before falling to the floor.

There could have been a serious injury or fatality but fortunately the gold room was empty at the time of incident. The IPSE circuit was subsequently taken out of service.



Figure 1 Damage caused when the 500 kg IPSE lid punched through the gold room roof

Probable causes

An independent investigation by a gold processing specialist advised that there had been a sudden and explosive release of energy due to hydrogen and oxygen build up in the electrowinning cell. These are normal gaseous by-products of electrowinning but the mixture is explosive if the gas space above the electrowinning cell is not continuously purged by the passage of compressed air. The most likely cause of gas build up inside the vessel was the blockage of the electrowinning cell purge air vent valve, which would normally allow gases to be continuously bled from the system.

The root cause analysis concluded that an incorrect valve had been installed for the pressure relief system. The purge air vent valve is a 25 mm ball valve that has no indication, alarm or system interlock to warn of purge flow restriction. The installed valve was the wrong design and did not comply with

Australian Standard AS 1210:2010 *Pressure vessels* — it should have automatically discharged fluid to the atmosphere, but did not.

A contributing factor was the poor condition and maintenance of the IPSE plant and equipment, as shown by an independent mechanical report. The plant was purchased secondhand and installed in 1999. Since installation, the level of automation for the circuit had been allowed to diminish as the programmable logic control (PLC) system, instrumentation and actuated valves were not adequately repaired or replaced as they failed, over at least several years. It was also later found that the IPSE circuit vent system did not meet the original design specification because a dedicated vent line to remove gaseous by-products during electrowinning was not installed as per the engineering design.

Action required

Regulation 6.26(1)(b) of the Mines Safety and Inspection Regulations 1995 requires compliance with Australian Standard AS/NZS 1200:2000 *Pressure equipment*. Under this standard, a pressure vessel should be protected with one or more pressure-relief devices to prevent the pressure from rising to more than 110 per cent of the vessel's design pressure (see Australian Standard AS 1210:2010 *Pressure vessels*).

To avoid a recurrence of this type of incident, mine site corrective actions include:

- undertaking an engineering review to identify alternative electrowinning systems that eliminate the need for a pressurised and purged system; and
- reviewing the design and process and instrumentation drawing (P & ID) of the elution circuit to determine its current design compliance.

Eliminating the requirement for a pressurised and purged system adopts the highest level of hazard control.

The engineering and design reviews need to consider all risks involving ignition sources and explosive or combustible materials during elution and electrowinning, and other hazards such as the production of toxic or asphyxiating gases.

The incident highlights the need to:

- seek specialist advice when designing or installing an elution and electrowinning circuit to ensure correct equipment and material selection;
- undertake appropriate risk assessment for the circuit, as required by regulation 7.27 for hazardous substance;
- implement a maintenance plan for classified plant and any connecting pipes and fittings; and
- provide operational training for all personnel who operate and maintain the circuit.



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