



**NSW
Resources
Regulator**

Investigation report

The death of Mark Siegel at mineral claim 44507 near
Lightning Ridge on 4 November 2016



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Executive summary

Incident overview

On 4 November 2016, Mark Siegel (52) and another worker (worker 2) were mining for opal at mineral claim 44507 in the Mulga Rush Opal fields about 60 kilometres south west of Lightning Ridge. Mr Siegel was working about 13 metres underground, operating a small electric bogger to move rock and earth material (known as mullock) from the face of the area being mined, to a large bucket in a sump at the bottom of the main shaft. Worker 2 was operating a small excavator commonly referred to as a digger.

Shortly before 3.00 pm, Mr Siegel approached worker 2 and told him that the bucket, which transported the mullock from the sump to the surface by means of a super hoist lifting system, was not returning down the shaft. Worker 2 suspected the bucket was stuck at the top of the hoist. Worker 2 told Mr Siegel he was going to the surface to investigate why the bucket was not returning.

Worker 2 then went to walk towards the exit (secondary) shaft when he saw Mr Siegel lower himself into the sump, retrieve a rock from the sump floor and throw it out onto the ground. Worker 2 then heard a loud noise and saw Mr Siegel trying to get out of the sump. The hoist bucket fell at high speed and hit Mr Siegel and he suffered fatal injuries.

Investigation observations

The Major Investigations Unit investigated the cause and circumstances of the death of Mr Siegel.

An Ag-Fab super hoist was being used at the mineral claim to transport the mullock to the surface.

The super hoist was owned by an individual (the plant owner) who was the business partner of Mr Siegel and worked the mine with Mr Siegel by agreement. The plant owner bought the super hoist in 2011. The plant owner maintained the super hoist.

The hoist was installed at the mineral claim about eight weeks before the incident. It was moved from a claim owned and operated by the plant owner. The investigation confirmed that the plant owner, Mr Siegel, worker 2 and another worker (worker 3) all participated in the installation of the super hoist.

Incident causation

Resources Regulator investigators and electrical and mechanical inspectors attended the incident site and examined plant and equipment. The examination consisted of an inspection of the hoist mechanical skip, hoist rails and winding system. The examination included hydraulic and electrical circuit components.

The incident was the result of a combination of failures that involved the hoist's hydraulic system being unable to control the rotation of the drum under fault conditions when power to the hoist was lost.

Under the fault conditions, the bucket acted as a counter weight that caused the winder drum to spin freely and resulted in the bucket free falling into the sump.

Foreseeable risks

Working under suspended equipment is a well-known risk in the opal mining community and the wider mining industry in general.

The risk of the bucket free falling was foreseeable and already known to the hoist owner and other workers. About one week before the incident, worker 2 reported the bucket free fell from the top of the hoist after it became stuck and the control panel was activated to lower the bucket. Worker 2 raised the issue with the plant owner on the afternoon of that event. However, the fault was not rectified.

Industry recommendations

A mine holder, mine operator and/or manager of plant and equipment of a mineral claim should:

- ensure all material hoists and winding systems are safe and fit for purpose
- ensure all plant and equipment is maintained by appropriately qualified personnel
- ensure adequate supervision and training of all people using plant and equipment
- undertake regular inspections and preventative maintenance of plant and equipment
- ensure a mine safety management plan is in place and adhered to before undertaking any work
- ensure appropriate risk assessments are completed and available to all workers
- prohibit all workers from working under suspended loads.

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1. Purpose

This report relates to the death of Mr Siegel on 4 November 2016 at mineral claim 44507 via Grawin NSW 2832. The report was prepared for the Secretary of the Department of Planning and Environment. It describes the mining workplace incident investigation conducted by the Resources Regulator's Major Investigations Unit into the cause and circumstances of the incident.

The purpose of the report is to assist the Secretary, as the regulator of work health and safety legislation at mines and petroleum sites, to learn about the incident and to share information with industry to improve industry safety and prevent similar incidents of this nature from occurring.

1.1. Major Investigations Unit

Safety investigators attached to the Resources Regulator's Major Investigations Unit (MIU) investigate the cause and circumstances of serious incidents in the NSW mining, petroleum and extractives industry. The MIU's role is to carry out detailed analysis of incidents and to report its findings to enhance industry safety and to give effect to the regulator's compliance and enforcement policy.

1.2. Investigation scope

All mining-related incidents that result in the death of a person are referred to the MIU in accordance with the Resources Regulator's policy. The investigation was conducted under the *Work Health and Safety Act 2011* (NSW). The investigation sought to determine:

- the cause and circumstances of the incident
- whether the mine operator, workers and others complied with their obligations under the WHS Act and Regulations, and
- how similar incidents of this nature can be prevented.

1.3. Legislative authority to investigate

The WHS Act governs health and safety at workplaces, including mining workplaces. The Secretary of the Department is the regulator under the WHS Act in relation to a mine or petroleum site to which the *Work Health and Safety (Mines and Petroleum Sites) Act 2013* applies.

MIU investigators are appointed as government officials under the WHSMPS Act and are deemed to be inspectors for the purposes of the WHS Act. The regulator has also delegated some additional functions to investigators, including exercising the power to obtain information and documents for the purposes of monitoring and enforcing compliance with the WHS Act.

The WHSMPS Act prescribes the meaning of a mine as 'a place that is a workplace at which mining operations are carried out' and mining operations as 'activities carried out for the purpose of extracting minerals from the ground and activities (including the handling, preparing, processing or storing of extracted materials) carried out in connection with mining activities at a local site.'

When this incident occurred, the plant owner (also business partner) and Mr Siegel, via an undertaking, were extracting mineral opal from the ground. Opal is a mineral under Schedule 1 Minerals of the Mining Regulations 2016.

1.4. Regulator's response to the incident

Inspectors from the Resources Regulator's Lightning Ridge office attended the scene after notification of the incident on Friday 4 November 2016. Initial information was obtained regarding Mr Siegel, worker 2, the plant owner and the nature of mining operations.

MIU investigators attended the incident scene on Saturday 5 November 2016.

Investigators conducted an assessment of the incident scene that included examining plant and equipment and taking photographs. Electrical and mechanical inspectors arrived at the site on Sunday 6 November 2016 to assist with further assessments.

1.5. Investigation information release

The Resources Regulator published an [investigation information release](#) on 15 November 2016. The information release reinforced the requirements to ensure workers do not undertake any tasks while under suspended or unsecured equipment. Mine operators were reminded to ensure all hoist systems functioned correctly and that they understood all design and functionality limitations of material hoists.

Information regarding duties in accordance with the WHS Act and the Work Health and Safety (Mines and Petroleum Sites) Regulations 2014 were also drawn to the attention of operators. Particular attention was drawn to the NSW Opal Mining Safety Guidelines (4th Edition 2010).

2. The deceased

Mr Siegel was a single man with no dependants. He lived on a residential (class A) mineral claim (No. 42770) at the Glengarry 6 fields. The claim was renewed by Mr Siegel, on 23 November 2015 for a period of five years and was due to expire on 31 October 2020.

Mr Siegel was living in the Grawin opal fields of Lightning Ridge since early 1992. Mr Siegel had experience mining on a small operational scale in various claims with his parents and later as an adult on his own.

Mr Siegel was a member of the State Emergency Service Glengarry Unit and had received an award for long service (10 years). He was well known within the Glengarry/Grawin opal fields.

3. Mineral claim 44507

3.1. Mine and incident location

MC 44507 is in the Mulga Rush opal fields between the Grawin and Glengarry fields about 40 km south-west of Lightning Ridge NSW. The Mulga Rush fields were founded in 1999. Opal in the Mulga Rush fields is commonly found in seams at depths of 3 to 20 metres.

Figure 1: Lightning Ridge in vicinity to Mulga Rush opal fields.

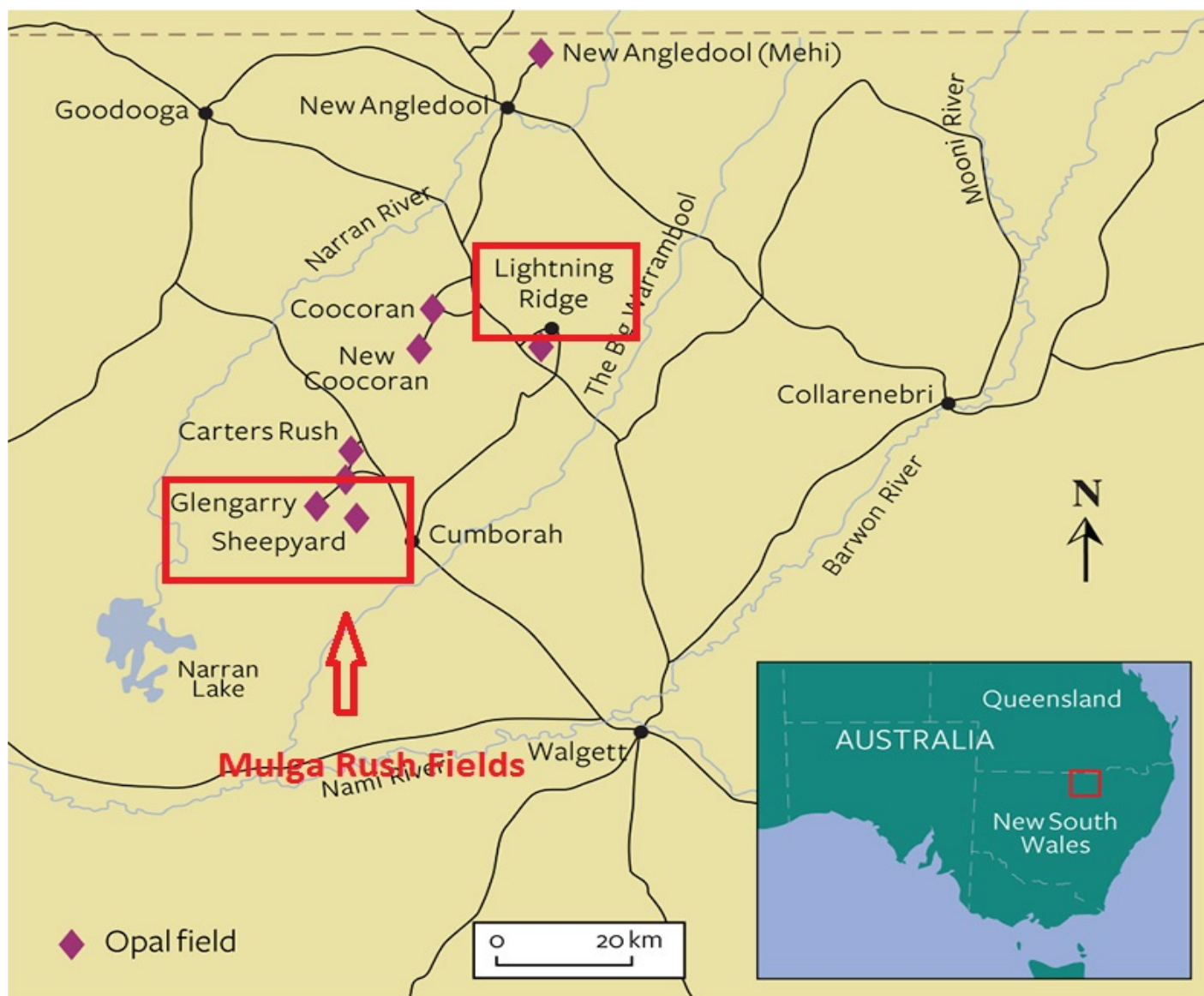


Figure 2: Aerial photograph of MC 44507 in the Mulga Rush opal fields.



3.2. Claim holder

The first mineral claim for MC 44507 was issued in December 1999 and renewed by various people until 2005. In November 2005, the existing claim holder applied for and was granted an ordinary mineral claim to mine for opal. The department issued a certificate of registration for 12 months, conditionally approving mining activities between 21 November 2005 and 31 December 2006.

The claim holder continued to renew the claim and in 2015 applied for a further renewal. The department granted the renewal and issued a certificate of registration to conditionally conduct opal mining activities from 23 November 2015 to 31 December 2020.

3.3. Mine operator

The authorised claim holder nominated an individual as the mine operator in accordance with the WHSM Regulations. The nomination was made in 2006, 2007 and again in 2008. The regulator has not received any further nominations for a mine operator since 2008.

At the time of the incident, Mr Siegel was actively mining the claim with the consent and knowledge of the claim holder. The mine operator had not actively operated or worked in the mine for several years, however agreed he was the nominated mine operator.

3.4. Safety management system

The Work Health and Safety (Mines and Petroleum Sites) Regulation 2014 required the mine operator to ensure the following, among other things:

- manage risks
- establish and implement a safety management plan.

At the time of the incident, the mine operator had not established or implemented a mine safety management plan.

Mr Siegel completed the Mine Safety Awareness Course on 15 June 1998. There is no requirement to renew the skills learned during the course once initially completed, despite mining and safety-related practices improving with technology and best practice principles over time.

The plant owner completed the Mine Safety Awareness Course on 9 November 2004 and the Mine Operator's Workshop on 11 November 2004, which was renewed on 26 October 2016, two weeks before the incident.

Records show worker 2 had completed the Mine Safety Awareness Course in 1999 and the Mine Operator's Course in 2012.

4. Circumstances of the incident

4.1. Chronology of the events leading to the incident

23 November 2015

Mineral Claim 44507 renewed for five years to expire on 31 December 2020.

2015 - 2016

Mr Siegel worked the claim. It was a small scale operation using a jackhammer, rickshaw and a small Teco Elec & Mach Co Ltd 3 HP 2.2KW winch with single phase induction motor. The bucket used in this operation was about 60 cm x 50 cm (substantially smaller than the bucket used in the super hoist operation).

September 2016

After an agreement to commence mining operations between Mr Siegel and the plant owner, an access shaft was drilled, the super hoist was installed and equipment (digger, bogger and power pack) lowered into the claim. Mr Siegel, the plant owner, worker 2 and worker 3 installed the super hoist. The hoist was used for larger mining operations, capable of moving large amounts of material than the smaller hoist previously used by Mr Siegel. The bucket dimensions of the super hoist were about 1.7 m (h) x 1.6 m (circumference) and weighed about 133 kg.

October 2016

An issue arose with the bucket during installation when activated in the rise sequence. The bucket remained in the dump position.

October 2016

The plant owner contacted worker 4 to attend claim 44507 and fix the issue with the hoist. Worker 4 went to the mine and replaced the top overload switch and thermal overload relay in the electrical control box. He tested the hoist and bucket sequence to ensure normal operations. Worker 4 reported that the hoist operated correctly.

October - November
2016

Mining operations commenced. Mr Siegel and worker 2 completed the majority of work in the claim, working four to five days a week.

The plant owner attended the claim on a weekly basis. He checked equipment and operated the digger occasionally.

4 November 2016
10-10.30 am After their respective cleaning duties, both Mr Siegel and worker 2 met at the Sheep-yard Hotel and travel to MC 44507 to work at the mine.

Worker 2 reported that he had completed the safety checks on the super hoist including checking the wire rope on the hoist, and the oil and fuel to the generator. After entering the mine through the entry/exit shaft, worker 2 began work on the digger and Mr Siegel began work and operated the bogger.

2.45 pm Mr Siegel approached worker 2, while he was working on the digger, and informed him the bucket was not returning down the shaft.

Worker 2 and Mr Siegel walked to the main shaft area. Worker 2 stated he told Mr Siegel he would return to the surface to find out why the bucket was not returning.

Worker 2 said he went to walk to the entry/exit shaft when he saw Mr Siegel lower himself into the sump to clean it out.

Worker 2 said he heard what he believed to be the bucket coming down the shaft. Worker 2 saw Mr Siegel attempt to get out of the sump, when the bucket hit him.

Worker 2 walked to the sump where he saw Mr Siegel between the side of the sump wall and the bucket. Worker 2 believed his injuries were fatal.

3.07 pm Worker 2 went to the surface where he made several phone calls to a mobile number owned by the plant owner.

3.08 pm Worker 2 then made two calls. Worker 2 then made a call to 112, which is a secondary emergency call number connected to Australian emergency services. NSW Ambulance was activated to attend the scene.

The plant owner and worker 3 attended the scene. Worker 3 entered the claim and checked Mr Siegel for signs of life. Worker 3 returned to the surface.

3.10 pm NSW Ambulance received the emergency call.

Ambulance from Lightning Ridge was dispatched at 3.16 pm and was on-route at 3.18 pm. An ambulance arrived at the scene at 4.06 pm.

Notes made by NSW Ambulance indicated they located Mr Siegel at the bottom of a mine shaft. There was no pulse and he had sustained injuries incompatible with life.

4 November 2016 3.45 pm	A Resources Regulator's officer was contacted by Lightning Ridge Police and advised of the incident.
4.42 pm	Regulator officers travelled to claim MC 44507. On arrival they spoke with NSW Police and other witnesses on site.
5.44 pm	A WHS Act section 198 non-disturbance notice was issued by the regulator. The scene was secured by inspectors overnight.
5 November 2016	NSW Police and SES recovered Mr Siegel's body.
1.00 pm	MIU investigators arrived at the scene and began their investigation.

4.2. Cause of death

An autopsy examination was conducted on Mr Siegel at the Newcastle Department of Forensic Medicine (Northern Forensic Hub) on 10 November 2016.

The report concluded Mr Siegel died on 4 November 2016 at Opal Mining Claim Number 44507, Grawin Opal Fields, Grawin NSW 2834 and the cause of his death was multiple injuries. There were no antecedent causes or other significant conditions that contributed to his death.

5. Causal factors

5.1. The hoist

The hoist involved in the incident was known as a 'super hoist' and was used through-out the mining fields of Lightning Ridge. The hoist was manufactured by Ag-Fab Pty Ltd of Goondiwindi. Records obtained by the department reveal Ag-Fab Pty Ltd went into liquidation in 2009 and the company owner died several months later. Investigators attempted to locate business records for Ag-Fab Pty Ltd without success.

The investigation confirmed the hoist's electrical system was supplied by Ag-Tronics also of Goondiwindi and was operating at the time of writing. Ag-Tronics obtained the electrical components from Ag-Fab and after assembling the components, supplied the electrical control box to Ag-Fab for installation on the hoist.

The bucket to the hoist was 1.52 m (front side) and 1.7 m (rear side) and had a circumference of 1.6 m. The bucket weight was approximately 133 kg.

The super hoist was bought second hand several years before the incident.

Figure 3: The Ag-Fab hoist on claim 44507.



Figure 4: The bucket of the Ag-Fab super hoist.



5.2. Operating the hoist

Mullock is trammed to the bucket using a bogger (figure 5). The mullock is deposited into the hoist bucket and raised to the surface by activating the start button on the lower control panel (figure 6). A steel cable attached to the bucket and drum (via a U clamp) winds around the hoist's drum (figure 7) in an under-wrap position when the bucket is raised to the surface (figure 8).

Figure 5: A bogger filled with mullock in front of sump located by investigators on 5 November 2017.



Figure 6: Hoist control unit (underground).

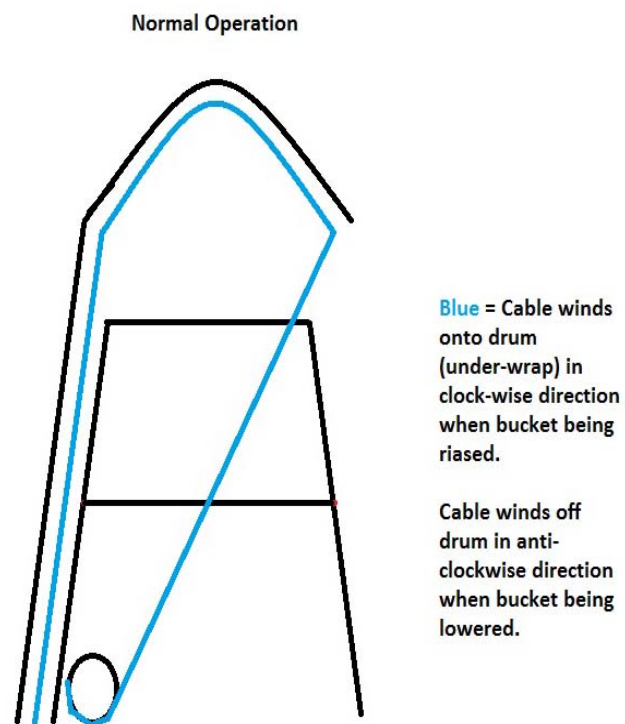
Note: the control panel underground was not labelled to indicate the operations of the buttons



Figure 7: Hoists drum and cable.



Figure 8: Cable spool and drum rotation in normal operation.



The bucket is raised out of the shaft and, after engaging the hydraulic arm, is pulled over the arc of the hoist into the tip position (figure 9). After several seconds the hydraulic arm retracts, and the bucket is lowered back down the shaft and into the sump. As the bucket enters the sump, a bracket on the side of the bucket activates a limit switch inside the sump that cuts power and the bucket comes to rest at the base of the sump.

Figure 9: The bucket in tip position (hydraulic arm engaged).



5.3. Limit switches

The Ag-Fab hoist has two limit switches. A limit switch is an electromechanical device that consists of an actuator mechanically linked to a set of contacts. When an object interacts with the actuator the device operates the contacts to make or break an electrical connection. The hoists limit switches are designed to send an electrical signal to the control box, which activates pre-programmed settings to raise and or lower the bucket. The first limit switch (figure 10) is at the top of the hoist and the second limit switch (figure 11) is inside the sump.

Figure 10: The limit switch at the top of the hoist.



Figure 11: The bucket in the sump (bracket and limit switch).



5.4. Hoist generator

The hoist was powered by a 240/415 volt Cummins Power Generator model ES62.5 (S/N 301141) in a shipping container near the super hoist (figure 12). The generator uses diesel fuel. The generator was made in Singapore with a manufacture date of 2003.

	Prime	Standby
Rated power KW	50	55
Rated power KVA	63	69
Rated current (0.8PF)	87	95

Voltage	240/415 V
Frequency	50Hz
Rotating speed	1500RPM
Battery voltage	12VDC
Control system	D521
Site altitude before derate	609m ASL
Site ambient temp before derate	38°C
Genset max. mass (kg)	1125

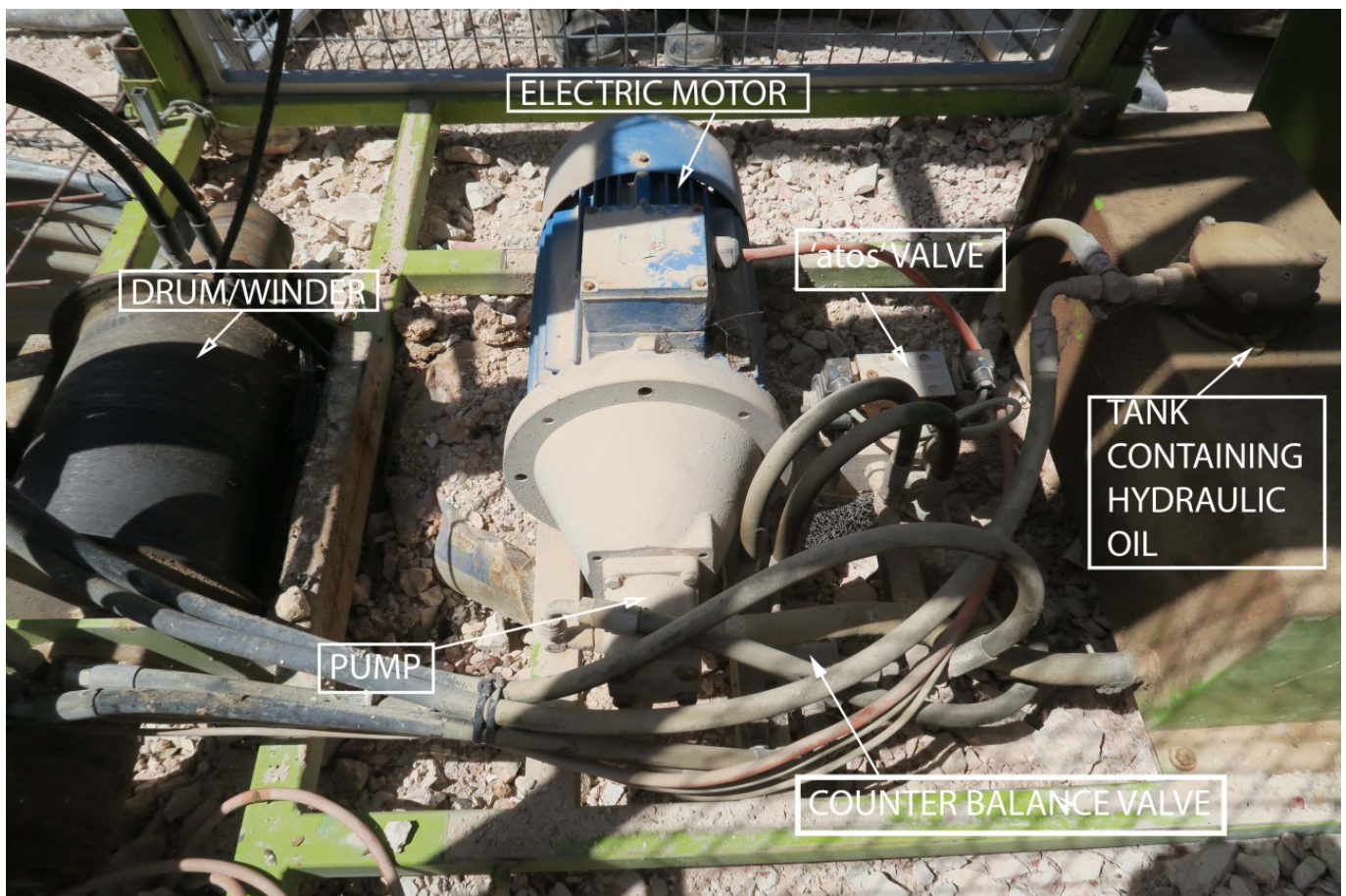
Figure 12: The generator that powers the electric motor to the hydraulic system and underground lights.



5.5. Hoist motor, pump and hydraulic system

Oil (hydraulic fluid) housed in the hydraulic tank is circulated through hoses by a Casappa pump powered by a western electric, 5.5 KW 415-volt induction motor. The oil circulates, under pressure, through the hoses and passes through a solenoid and counter balance valve, both of which direct the flow of oil. The oil moves through the system via the pump, which generates enough pressure to turn the hoists drum, winding the cable on and off.

Figure 13: The hoist hydraulic electrical/mechanical system at MC 44507.



5.6. Solenoid valve

The solenoid valve was manufactured by Atos (Italy) and imported and distributed in Australia by Southcott Pty Ltd (figure 14). The original valve model was number DKU-1713-X-00 (figure 15), however at some point it was converted by person(s) unknown to model DKU-1710-X-00 (figure 16). Examination of the valve revealed a new model number was stamped over the original number. The manufacturer of the hoist, Ag-Fab Pty Ltd, bought a large number of items, including solenoid valves, hoses and other equipment from Southcott Pty Ltd over several years.

Figure 14: The Atos solenoid valve.

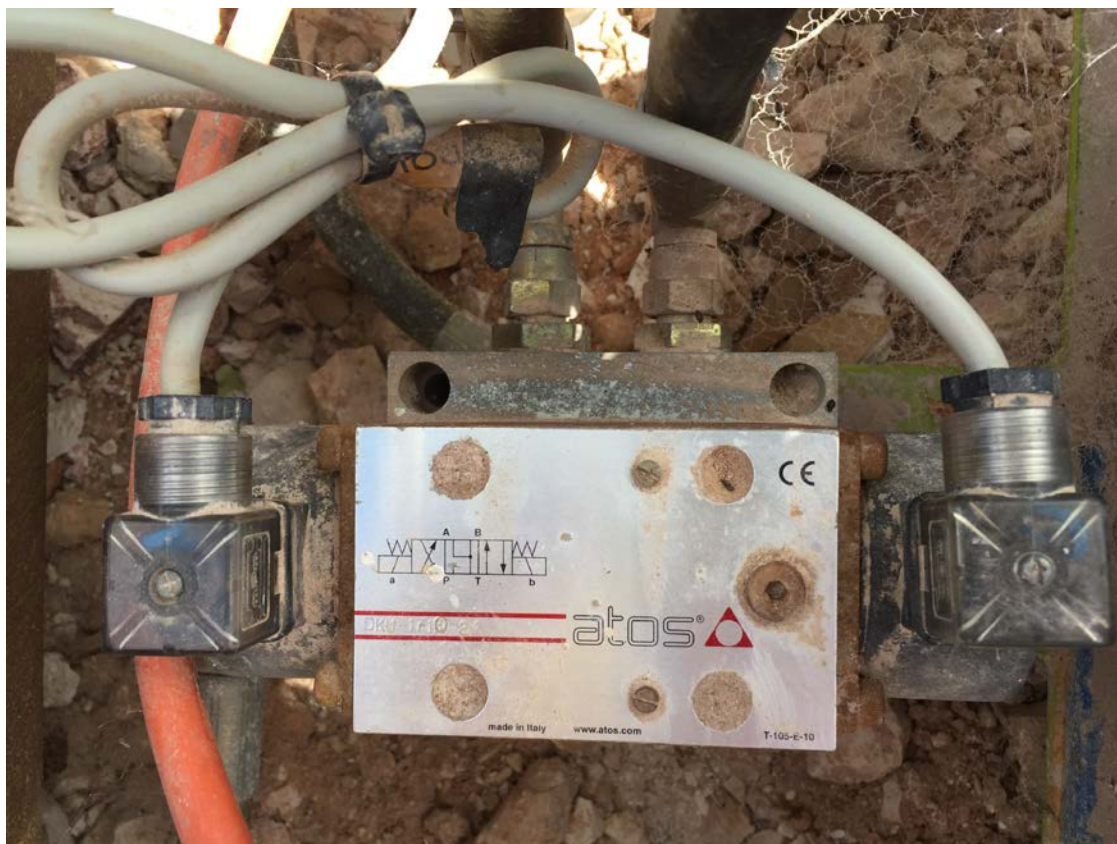
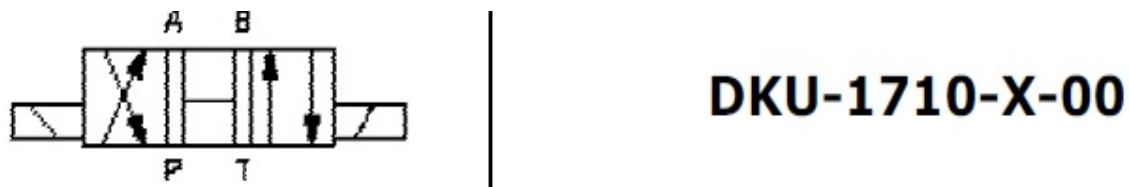


Figure 15: Solenoid valve configuration before conversion.



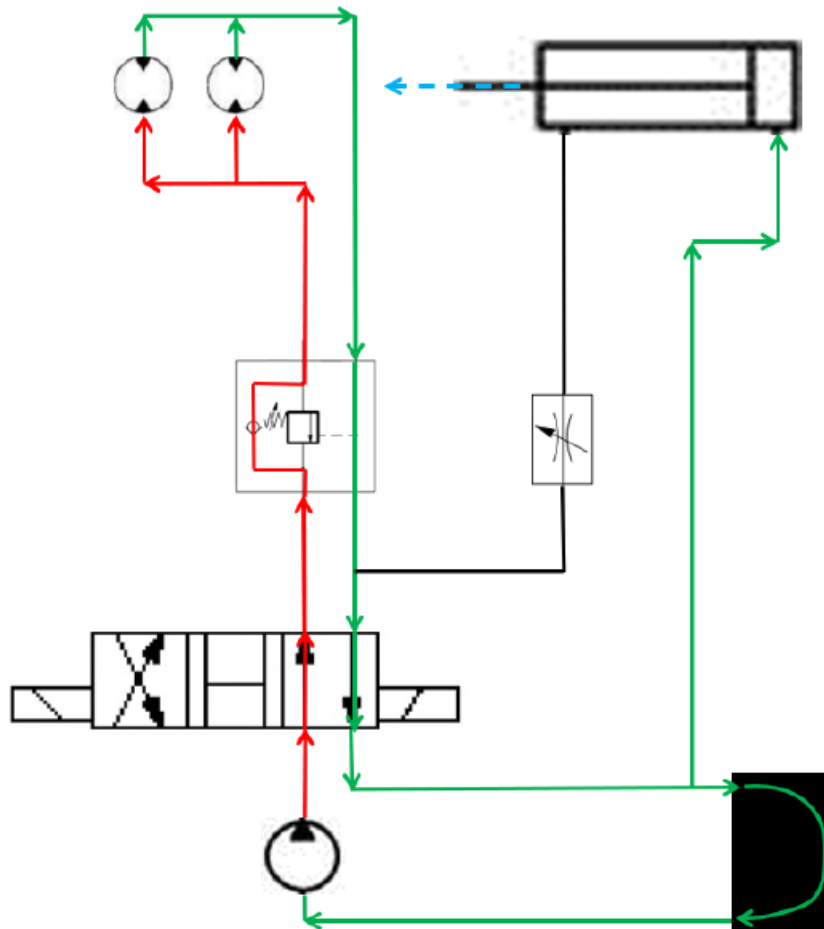
Figure 16: Converted solenoid valve configuration in the system at the time of the incident.



Inquiries made with Southcott Pty Ltd identified Southcott used to be authorised to convert valves, however Atos removed conversion approvals by all distributors worldwide about 10 years ago.

The valve is a three-position, four-port valve that directs the flow of oil through the hydraulic system. The valve generally remains in the centre position and when the hoist bucket is activated to rise, the valve moves left, engaging the far right port with the up-down arrows (figure 17).

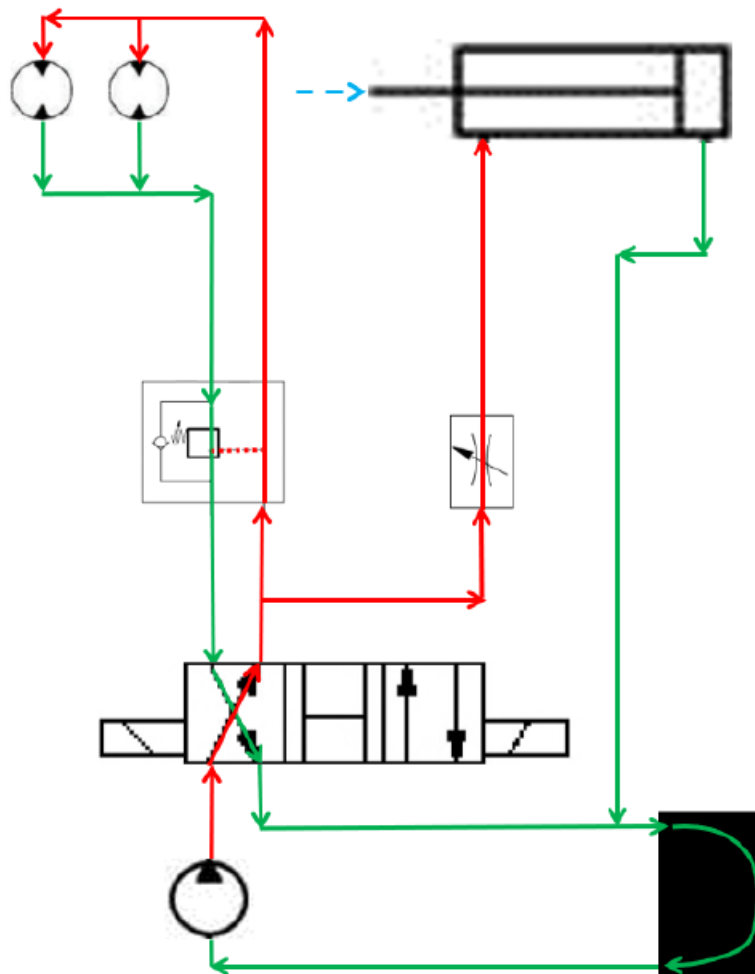
Figure 17: The solenoid valve during the hoist lift sequence.



In this position, oil flows from the tank to the solenoid valve then the counter balance valve and onto the drive motor, which turns the drum in a clockwise direction. As the bucket rises, the cable is wrapped around the drum. The bucket then engages the hydraulic arm and moves into the tip position for several seconds.

The limit switch on the arc at the top of the hoist signals the solenoid (figure 14). The valve then moves right, engaging the far left port with the arrows that cross over (figure 18). The direction of the oil flow is reversed, turning the drum in an anti-clockwise direction (lowering the bucket).

Figure 18: The solenoid valve during the hoist lowering sequence.



5.7. Counter balance valve

Counter balance valves are used in hydraulic systems working with suspended loads. They are designed to create back pressure at the return line of the actuator to prevent losing control over loads. A counter balance valve on a hoist's hydraulic system ordinarily prevents the weight of the load causing the hoist's drum to turn or spin feely in its normal operation.

Simply put, the function of a counter balance valve, as the name suggests is to counter the weight of the hoist's bucket, when the hydraulic system is not powered, i.e. when the electric motor and so hydraulic pump is not running and when the spool (solenoid) valve is in the centre, rest position, so that the hydraulic motors are not 'engaged' with the hydraulic pump.

The valve on the Ag-Fab hoist's hydraulic system is a Walvoil 4 port- single acting counter balance valve (Single acting – allowing flow in one direction only with a spring-loaded return actuator), part No. VOS/SC 38/TR.S.p4.PG (figures 18 and 19). An example of the counter balance valve in its rest position, that is when the hoist is not in operation, is shown in figure 20.

Figure 18: Schematic of the counter balance valve.

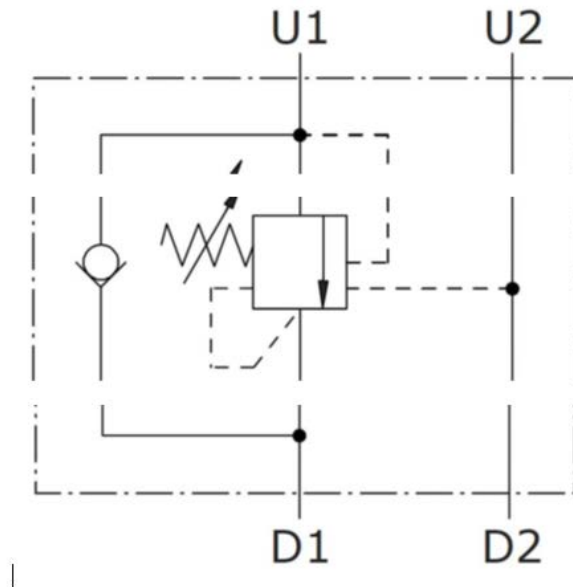
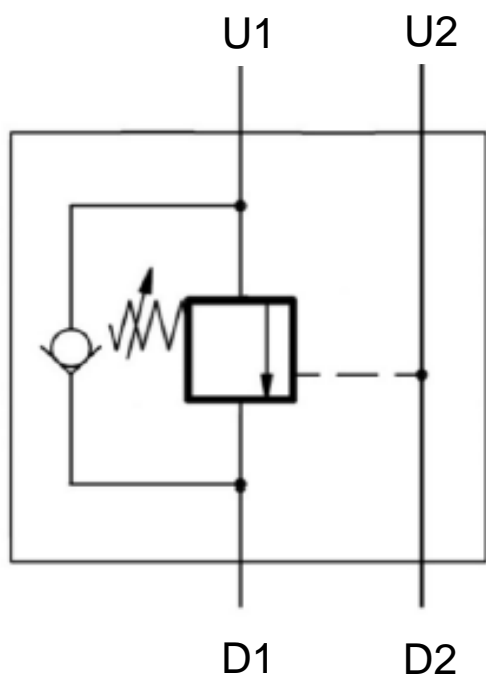


Figure 19: The counter balance valve sized from the hoist.

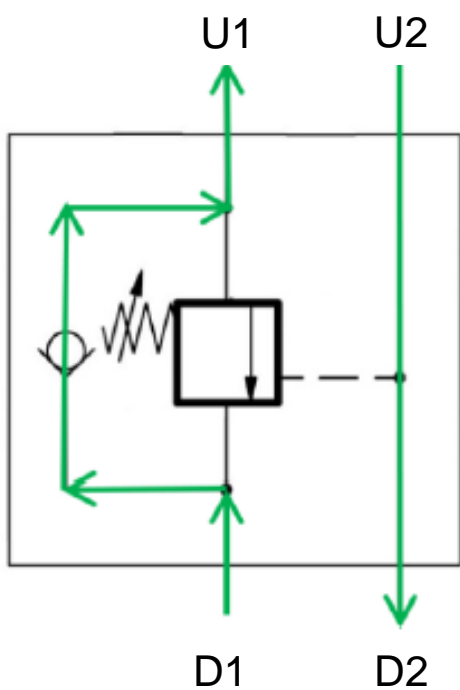


Figure 20: The counter balance valve in rest state.



When the hoist's bucket is being operated in the raise sequence (that is, from the sump to above the ground) oil will flow forward through the counter balance valve via port D1 and U1, before entering the drive motor to turn to drum (raising the bucket) and return to the tank via ports U2 and D2 (figure 21).

Figure 21: The counter balance valve forward flow of oil.



When the bucket is being operated in the lowering sequence, oil will flow through the counter balance valve in reverse, flowing through ports D2 and U2 and returning via ports U1 and D1. Reverse flow is generally prohibited due to a ball valve (figure 22). To achieve reverse flow a pilot signal, activated by the pressurised oil (figure 23 red lines), aligns the port to allow oil to return to the tank (figure 23). The operation of this valve was described as:

'Freewheeling of the hydraulic motors is prevented in only one direction, the reverse direction, this type of counter balance is called a single acting counter balance valve.'

Figure 22: Flow of oil prevented due to the ball valve.

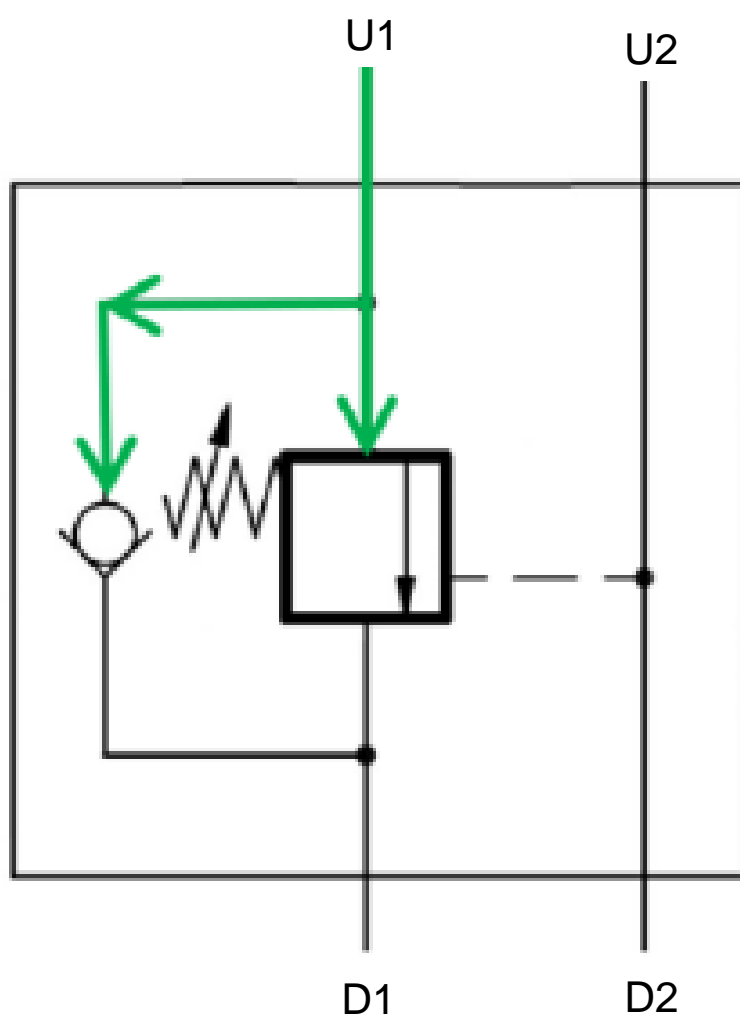
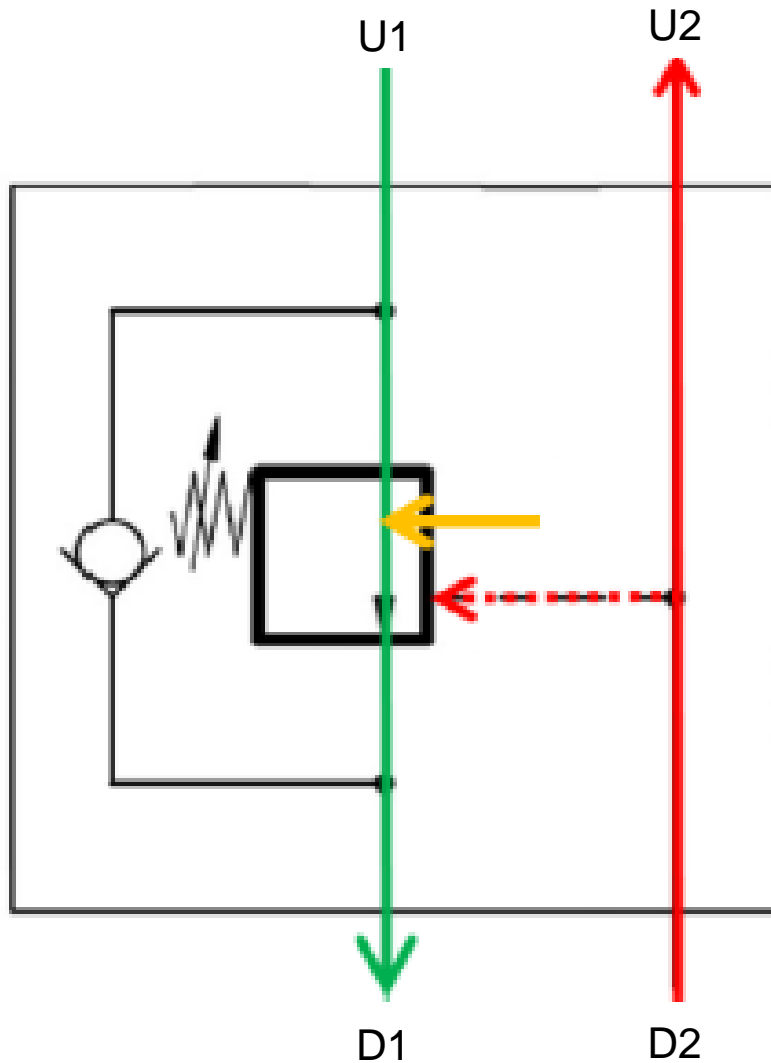


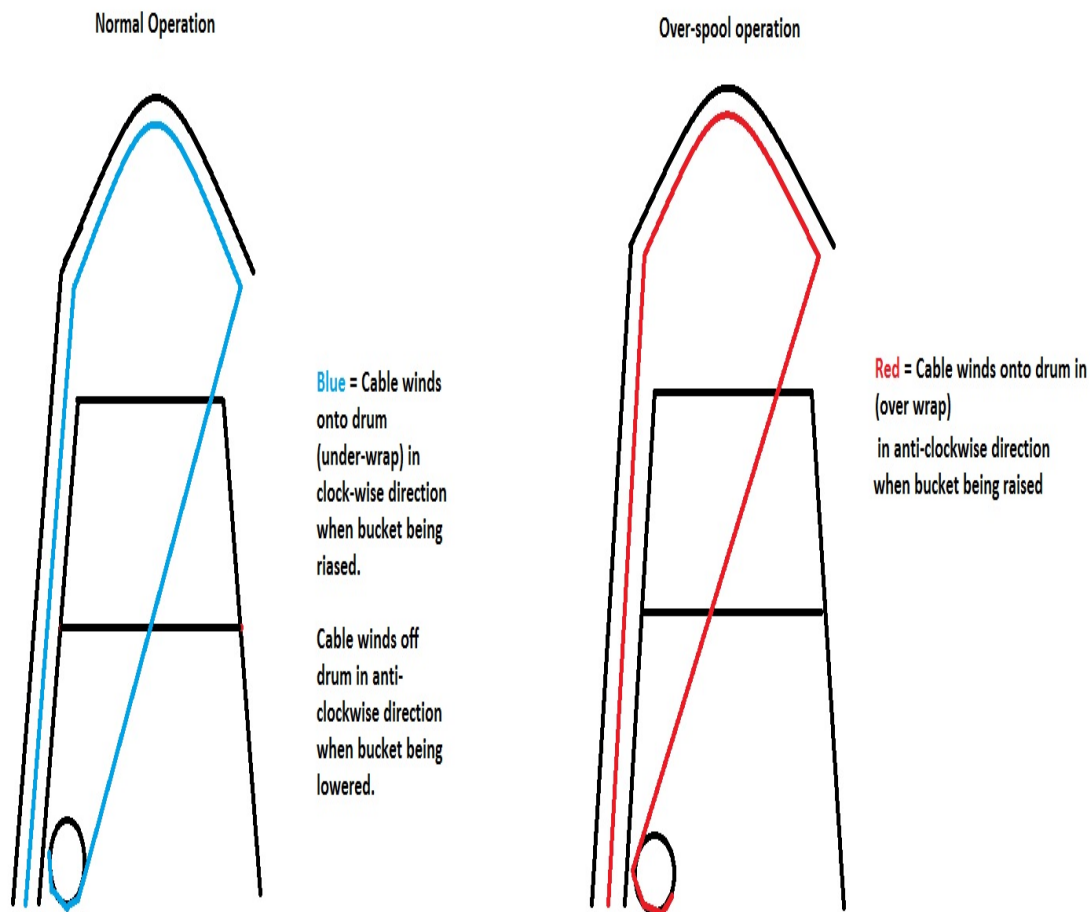
Figure 23: The counter balance valve pilot signal (green line) activated to allow the reverse flow of oil.



5.8. Identified fault condition

The hoist bucket is raised and lowered by the hydraulic system turning the drum, which houses the steel cable. The steel cable is attached to the drum via a U-clamp at one end and attached to the bucket at the opposite end. In the event that the limit switch inside the underground sump is not activated, the cable continues to unwind. When fully unspooled, the drum continues to turn causing the cable to wind onto the drum in the wrong direction (figure 24). This causes the bucket to unintentionally rise back to the surface.

Figure 24: Normal and over-spool operation of the hoist's drum and cable.



As the bucket reaches the arc of the hoist, it hits the hydraulic arm brackets. However, as the hoist's electrical system has not detected the lower limit switch being activated, it will not allow the bucket to engage with the hydraulic arm (figure 25). The bucket remains in this position with the hoist's motor still running.

Figure 25: The bucket unable to fully engage into the tip position.

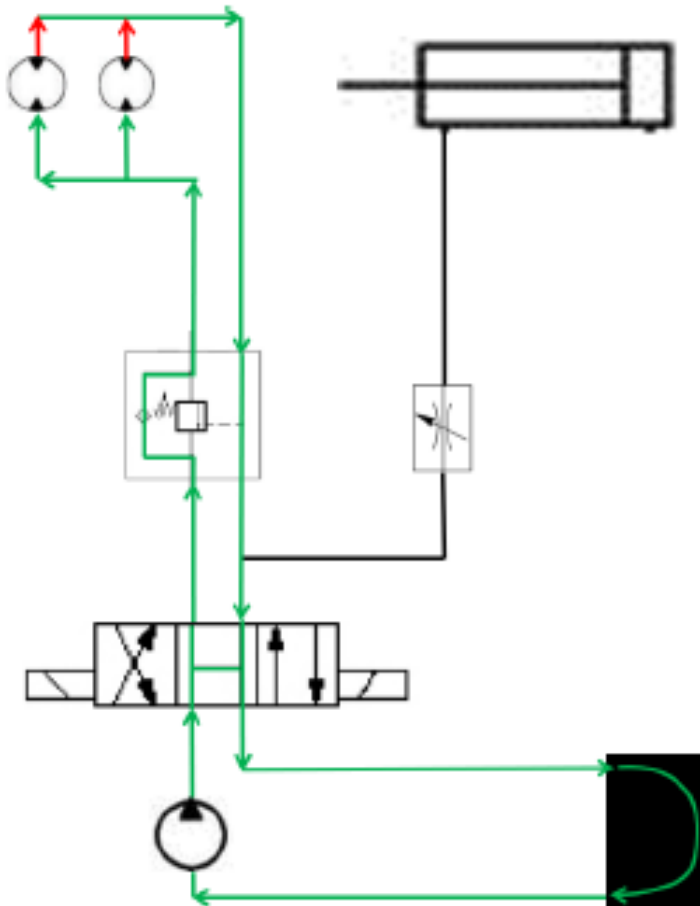


When this occurs, the hoist's hydraulic oil is being pumped, under pressure, through the system as shown in figure 17. When power is lost, the solenoid valve returns to the centre or rest position.

The weight of the bucket then turns the motors (freewheeling) and because of the counter balance valve being single-acting (figure 18 and 22) there is no resistance to the motors pumping oil forward (figure 26) resulting in the motors turning and the bucket free-falling down the shaft.

Figure 26: The over-spool hydraulic scenario with motors rotating pumping oil forward.

The counter balance valve was (only) single acting, there would have been no material resistance to the hydraulic motors pumping fluid 'forwards', and the bucket would not have been braked.



5.9. Potential loss of power to the hydraulic system

The function of a counter balance valve is to provide a braking system to a hoist's hydraulics in the event of loss of power. The investigation identified four possible causes of loss of power to the Ag-Fab hoist.

1. Activation of limit switches (loss of electrical power).
2. Other failure of the electrical system.
3. Failure of the generator.
4. Hydraulic hose failure.

An examination of the hoist's hydraulic and electrical system was completed by investigators and mine safety engineers. While some unrelated electrical issues were observed (see section 8), there was no evidence to support a finding that there were any electrical or hydraulic (hose) malfunctions, which contributed to the incident. Worker 2 provided evidence that showed the generator had sufficient fuel

before mining operations commenced. Evidence from other witnesses indicated that the generator was operating shortly before the incident occurred.

Investigators conducted controlled tests on the hoist system. When the hoist was in an over-spool scenario the bucket jammed against the hydraulic arm and the hydraulic electrical motor went into overload (full running load for 10 minutes). The full load current of the motor was recorded at 10.9 amps and the measured current load during overload was 13.9 amps. This should have triggered the overload relay in the hoist's electrical control box to trip the main contactor, that is lose power.

The overload relay was seized and retested later, which revealed it was the incorrect size for the hydraulic motors' operation having been set at 18 amps. This setting would prevent the overload relay from operating.

Ordinarily, if the correct overload relay was installed, power would have been lost and the same result would have occurred (the bucket would have free fallen).

The inspection and testing of the hoist's functions eliminated all causes of a potential power loss except for the activation of the limit switches. This was consistent with the account of worker 2, the only witness to the incident.

5.10. Description of the incident

On 4 November 2016, Mr Siegel was 13 metres underground mining for opal with worker 2. Mr Siegel was operating a small electric bogger to move rock and earth, known as mullock, from the working face to the hoist bucket in the sump at the bottom of the main shaft. After filling the bucket with mullock, Mr Siegel activated the bucket to the rise function with the underground control unit, which sent the bucket to the surface. The bucket tipped the mullock into a truck positioned below the hoist then entered the lowering sequence.

The lower limit switch was not activated when the bucket entered the sump. This could have been as a result of the bucket's bracket missing the lower limit switch due to its position (upon inspection of the lower limit switch it was found to have been loose and not secure, however, it cannot be determined if this was as a result of the incident or if it was poorly installed, or mullock in the bottom of the sump preventing the bucket lowering sufficiently for the bracket to activate the limit switch.

Due to the limit switch not being activated, the hoist's drum continued to turn, unspooling the cable. This caused the cable to wind onto the drum in the wrong direction and lifted the bucket unintentionally back to the surface.

The bucket then became lodged against the hoist's hydraulic arm. The hoist's electrical system signalled the bucket was still being lowered preventing the hydraulic arm from activating. The bucket remained at the crest of the arc working against the hydraulic arm. The electrical overload relay did not activate.

Shortly before 3.00 pm, Mr Siegel told worker 2 the bucket was not returning to the sump. Worker 2 walked to the sump and looked up the shaft. He could see the bucket suspended near the top of the hoist's ladder. As worker 2 walked towards the exit shaft he saw Mr Siegel lower himself into the sump.

Worker 2 heard a loud noise and then saw the hoist's bucket strike Mr Siegel.

5.11. Incident recreated

Investigators reconstructed events, under controlled conditions, using information provided by worker 2 and the plant owner. The hoist's functionality was tested and the bucket rose from the sump to the surface, engaged the hydraulic arm, and moved over the arc and into the tip position. After a few seconds, the hydraulic arm retracted and the bucket was observed to lower back down the shaft and activate the lower limit switch. Normal operation was observed.

Investigators then caused the bucket to rise, tip and lower again under fault conditions. In these conditions, the lower limit switch was not activated and the hoist's cable was observed to continue to fully unwind. The hoist motors continued to turn the drum and the cable wound onto the drum in the wrong direction causing the hoist bucket to rise to the surface and make contact with the hydraulic arm bracket.

The hydraulic arm did not engage and the bucket remained static near the crest of the hoist's arc. The hoist's winch ceased winding, however the motor continued to operate the hydraulic system forcing the bucket to remain in a static position suspended above the shaft.

Under controlled conditions, the lower limit switch was then activated cutting power to the hoist motor. The bucket was witnessed to free fall at speed from its position down the shaft. The bucket fell with significant force taking approximately three seconds to travel 19 metres and impacted heavily with the sump floor.

6. Foreseeable risks

Working under suspended equipment is a well-known risk in the opal mining community and the wider mining industry in general. The investigation confirmed the likelihood of the bucket free-falling was already known to the hoist's owner and other workers.

On 16 November 2016, investigators attended another mineral claim (MC 59019) where they met the mine holder. The mine holder was aware of the cable over-spool issue with the Ag-Fab hoists, causing buckets to free fall. The mine holder had engineered a solution on a super hoist to detect cable over-spool, which activated a braking system, preventing the drum from turning and releasing the cable. It was reported that this engineering solution was low cost and easy to fabricate and install.

The plant owner was installing a similar device on the incident hoist to prevent a recurrence of the incident.

7. Other electrical safety issues

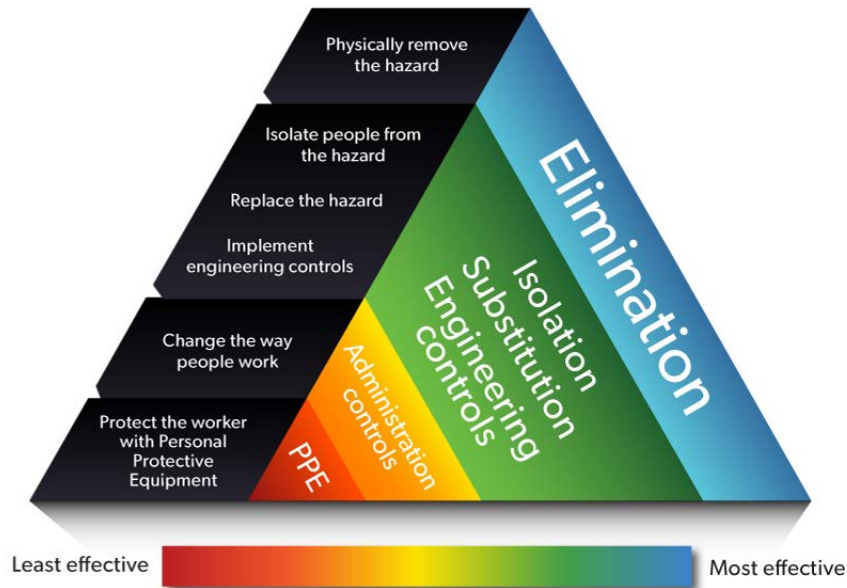
During the examination of the incident scene, investigators and mine safety electrical inspectors identified several electrical safety issues that were not linked to the incident including:

- frayed electrical cables
- incorrect overload relay (generator)
- damaged cable plugs
- no earth leakage protection (generator)
- no battery isolator was fitted

- no residual current devices were fitted to the 240-volt outlets
- poor wiring practices (electrical circuitry and generator).

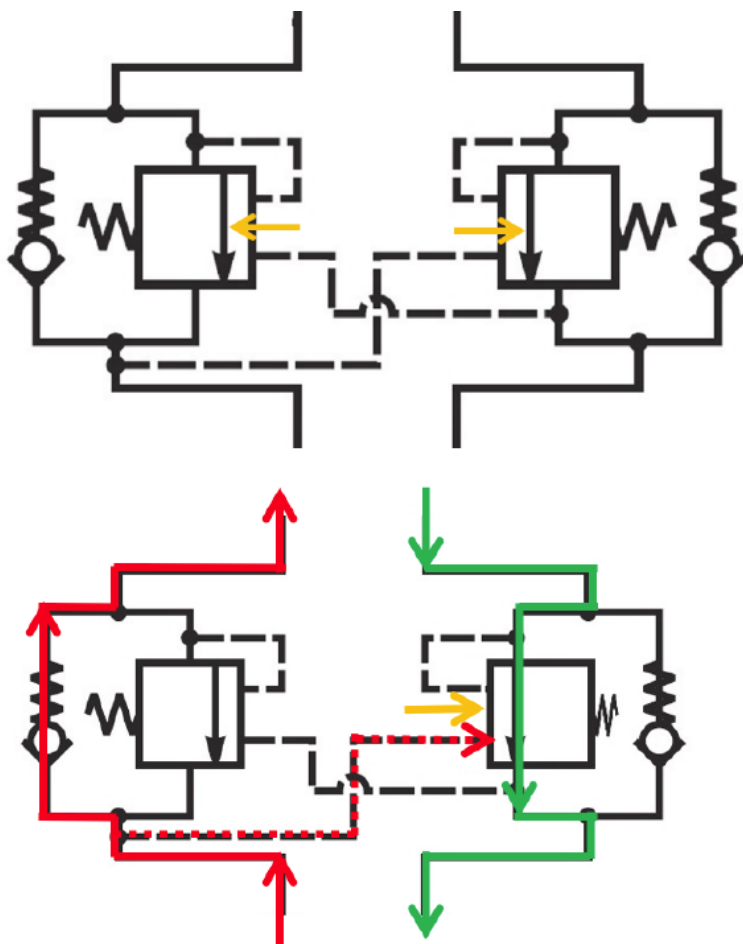
8. Reasonably practicable measures

The hierarchy of controls is well known and identifies controls from least effective to most effective.



The investigation identified several engineering controls that could have prevented the bucket from free falling. The simplest and most inexpensive of these involves fitting a dual acting counter balance valve to the hydraulic system (figure 28), which would have braked the hydraulic motors from turning (free-wheeling), in the event the bucket acted as a counter weight while the hoist is in an over-spool scenario during loss of power.

Figure 28: Schematic of the dual-acting counter balance valve (pilot signal required for both forward and reverse direction).



9. Recommendations to industry

A mine holder, mine operator and manager of plant and equipment of a mineral claim should:

- ensure all material hoists and winding systems are safe and fit for purpose
- ensure all plant and equipment is maintained by appropriately qualified personnel
- ensure adequate supervision and training of all persons using plant and equipment
- undertake regular inspections and preventative maintenance of plant and equipment
- ensure a mine safety management plan is in place and adhered to prior to undertaking any work
- ensure appropriate risk assessments are completed and available to all workers
- prohibit all workers from working under suspended loads.