NSW Coal Mines

High Pressure Hydraulics

Incident Analysis

Review of incidents from
January 2007 to December 2010

CMH&S Regulation 2006 Clause 56(1)(o)
an escape of fluid under pressure that could place any person at risk

Report Date: February 2011

Disclaimer

1 April 2011

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1 Introduction

Foreword

Pressurised fluid power systems are used as an energy source on mechanical equipment in mines. The escape of high pressure fluid is a potential major hazard which if uncontrolled can lead to serious outcomes including traumatic fluid injection injury and even fatality.

In 2003, mechanical inspectors analysed the circumstances and outcomes of recent failures of pressurised fluid power systems in NSW coal operations, some of which resulted in fluid injection injuries.

Subsequent risk mitigation work by the inspectorate with industry led to a decision to include in the Coal Mines Health and Safety Regulation 2006 (CMHSR 2006) a new clause 56(1)(o), which requires mandatory notification of any “escape of fluid under pressure that could place any person at risk”.

The present report analyses all notifications of 56(1)(o) escape of fluid incidents and people involved in these incidents, in the four years to December 2010, as recorded in the Industry & Investment NSW COMET database.

From 2007 to 2010 there were no fatalities due to an escape of fluid, however two fatal incidents did occur on NSW longwall mining equipment in November 1991 and July 2006.

See also: *MDG 41 Guideline for fluid power system safety at mines*
http://www.dpi.nsw.gov.au/minerals/safety/publications/mdg

Incident and Injury Notification Legislation

Coal Mines Health and Safety Act 2002 (CMHSA 2002)

> ***Section 110(1)(a)*** *any incident at the coal operation that has resulted in a person being killed*
>
> ***Section 110(1)(b)*** *any other incident at the coal operation of a kind prescribed by regulations for the purpose of this paragraph*

Coal Mines Health and Safety Regulation 2006 (CMHSR 2006)

> ***Clause 56(1)(o)*** *an escape of fluid under pressure that could place any person at risk*
>
> ***Clause 55(a)(v)*** *an injury to a person that results (at any time after the injury) in the injection of fluid (including hydraulic fluid, oil, air or water) under pressure*
>
> ***Clause 55(c)(v)*** *any event or circumstance that presents an immediate threat to life or of permanent incapacitating injury – serious burns to a person*
>
> ***Clause 55(b)*** *an event that results (at any time after the event) in the admission of a person to hospital as an in-patient*
>
> ***Clause 56(1)(a)*** *an injury to a person that results in the person being unfit, for a continuous period of at least 7 days, to attend the person’s usual place of work, to perform his or her usual duties at his or her place of work or, in the case of a non-employee, to carry out his or her usual work activities (where that unfitness is supported by a medical certificate).*

2 Summary

This report analyses all incidents notified by NSW coal operations under *CMHSR 2006 Clause 56(1)(o) an escape of fluid under pressure that could place any person at risk* and any resulting injuries/suspected injuries to people involved in these incidents for the 4 year period from 1 January 2007 to 31 December 2010.

If analysed on a quarterly basis, the number of 56(1)(o) escape of fluid incidents in NSW coal operations is declining and appears to have plateaued over the last 12 months, although the Hunter Region has seen a slight rise over the last 3 quarters. Analysis by financial year (the normal I&I NSW reporting period) also shows a decline, but having only six months in the last data point on the graph does not reveal this trend as clearly. A high number of reportable incidents in the first two years of the CMHSR 2006 may have been partly the result of over-reporting due to unfamiliarity with the new legislation.

In the four calendar years 2007 to 2010, there were 1,186 escape of fluid incidents notified under CMHSR Clause 56(1)(o), involving 152 people. Five people sustained fluid injection injuries (notified under CMHSR Clause 55(a)(v)), and one person sustained a serious burn injury (notified under CMHSR Clause 55(c)(v))

There were 1,186 incident notifications under CMHSR 2006 Clause 56(1)(o)

- 12.8% of fluid escape incidents involved an injury or suspected injury to people
    - 56.6% of the people involved were sent to hospital (7.7% of all incidents)
    - 9.9% of the people involved were admitted to hospital as an inpatient (1.26% of all incidents)
    - 3.3% of the people involved suffered a fluid injection injury (0.42% of all incidents)

The treatment ratio of people with an injury or suspected injury in the last 12 months is similar to that for the 4 year period as a whole.

The most likely bodily location to be struck with fluid is around the hands/fingers, face and arm/forearm areas. This is reflected in both the 4 year period and the last 12 months and is consistent with people working on, or in close proximity to, hydraulic equipment.

The most likely mine location for a 56(1)(o) escape of fluid incident to occur is on a longwall face (52%) then development units (33%), outbye (13%), surface (1.5%) and open cut (1%). This is understandable owing to the large number of hoses and connections on a longwall face and the proximity of people to hoses while the hoses are pressurised.

3 56(1)(o) Escape of Fluid Incidents

This section provides a breakdown of 56(1)(o) Escape of Fluid Incidents notified to I&I NSW for the period from January 2007 to December 2010.

Most NSW coal mines appear to be reducing the frequency of 56(1)(o) Escape of Fluid Incidents over time.

Most longwall mines have general inspection of hoses and staples (visual inspection) on a shiftly and weekly basis by tradesmen. Note: the visual inspections are not very effective as the hoses and staples are generally covered, with sleeving, coal, guarding, and other hoses. The total number of hoses on a longwall makes it difficult to see individual hoses and it is confusing to inspect individual hoses. This visual inspection is also carried out when component replacement and repairs are carried out.

Most longwall mines have third party audits (some have two independent auditors namely the OEM equipment & OEM hose suppliers) conducted on hoses and staple inspections based on the normal number of cycles in each separate circuit. Over an 18-24 month period the leg circuit might be audited 4 times, DA ram (double acting advancing ram) 4 times and the rest of the circuits 2 times. The audits are resource-intensive inspections (people, time, equipment) and provide a higher level on integrity to normal inspections.

Hose and fitting audits examine the acceptability of all high pressure systems in the longwall. Audits typically require 100-150 hours to complete all circuits, with additional time for preparation for the examination (cleaning in area, etc). Some examinations require several maintenance shifts to complete.

Most longwall mines will replace hoses and staples (or hoses and staples on a specific circuit) on the basis of time, distance, numbers of pushes/advances, or an end of block, all based on the number of pressure cycles in the circuit (fatigue failure mode) on the roof support.

One mine takes samples of hoses and staples on all circuits (i.e. replace all hoses on a number of shields, identifying each hose) then inspecting the hoses and staples, then testing the hoses to burst to determine the remaining life of the hose, based on Factor of Safety (FOS) of Working Pressure to Burst. This information is reviewed against the plan for the next block to decide if any modification to the plan is required regarding hose and staple replacement.

With more employees and contractors checking, inspecting, auditing and replacing the hoses on a periodic basis, this has increased the numbers of people and their time exposure to the high pressure hazard associated with the longwall hoses.

Hose degradation is a reality, all hoses have a finite life and the aim is to develop a maintenance strategy that prevents them from reaching failure.

Evaluation of hose failure modes reveals two scenarios, either:
1. the hose was not installed correctly for the application; or
2. the fluid power system or operating environment has impacted the serviceable life of the hose.

A number of incidents have also been attributed to excessive corrosion caused by coal fines on and around the hose ends, which corrode any steel components. So your maintenance scheme, which is part of the production cycle, should include periodic and or regular hosing down of the supports. Ensure that operational people keep the working environment clean, as this will assist operators but will also reduce your hose failure rate and improve safety. There have been a number of incidents where employees were replacing hoses and or staples as part of the preventive maintenance strategy. Tradesmen have been known to leave staples out and re-energised the hydraulics resulting in people being struck by high pressure fluid.

Common wear and tear areas are usually known by longwall engineering people. All mines should have EFFECTIVE hose integrity check/replacement protocols in place.

Refer to Section 3.5.1 for details of 56(1)(o) Escape of Fluid Incidents on Longwalls.

Refer to Section 3.5.2 for details of 56(1)(o) Escape of Fluid Incidents in Development Units.

3.1 Number of NSW Coal Mines by Region and Operation Type

Figure 1
Number of NSW Coal Mines by Region and Operation Type Dec 2010

Area	Region	Underground	Surface		Exploration	Total
			Open Cut	Processing		
North East Area	Hunter	15	23	10	0	48
	Northern	1	5	2	1	9
	Total	16	28	12	1	57
South East Area	South Eastern	17	5	6	1	29
Total		**33**	**33**	**18**	**2**	**86**

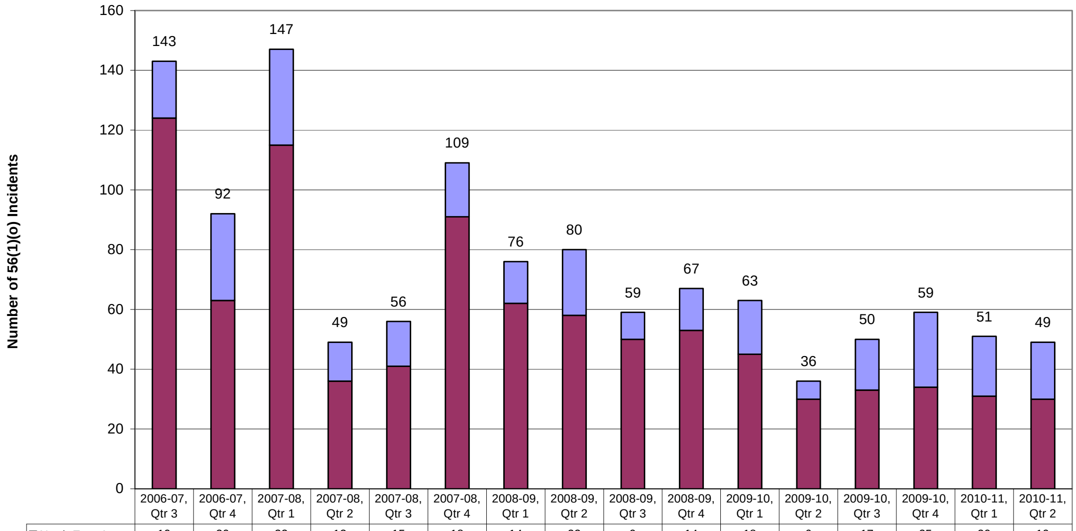
3.2 56(1)(o) Escape of Fluid Incidents by Region and Operation Type

Figure 2
56(1)(o) Escape of Fluid Incidents by Region and Operation Type Jan 2007 to Dec 2010

Area	Region	Underground	Surface	Total
North East Area	Hunter	272	12	284
	Northern	3	3	6
	Total	275	15	290
South East Area	South Eastern	892	4	896
Total		**1167**	**19**	**1186**

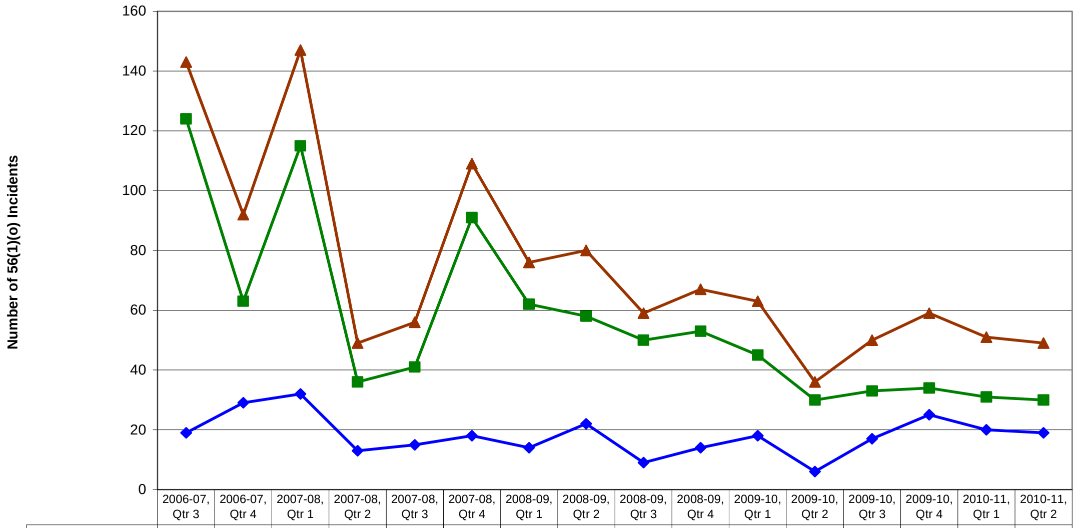
3.3 56(1)(o) Escape of Fluid Incidents by Quarter

Figure 3
56(1)(o) Escape of Fluid Incidents by Quarter Jan 2007 to Dec 2010



	2006-07, Qtr 3	2006-07, Qtr 4	2007-08, Qtr 1	2007-08, Qtr 2	2007-08, Qtr 3	2007-08, Qtr 4	2008-09, Qtr 1	2008-09, Qtr 2	2008-09, Qtr 3	2008-09, Qtr 4	2009-10, Qtr 1	2009-10, Qtr 2	2009-10, Qtr 3	2009-10, Qtr 4	2010-11, Qtr 1	2010-11, Qtr 2
North East Area	19	29	32	13	15	18	14	22	9	14	18	6	17	25	20	19
South East Area	124	63	115	36	41	91	62	58	50	53	45	30	33	34	31	30
Total	143	92	147	49	56	109	76	80	59	67	63	36	50	59	51	49

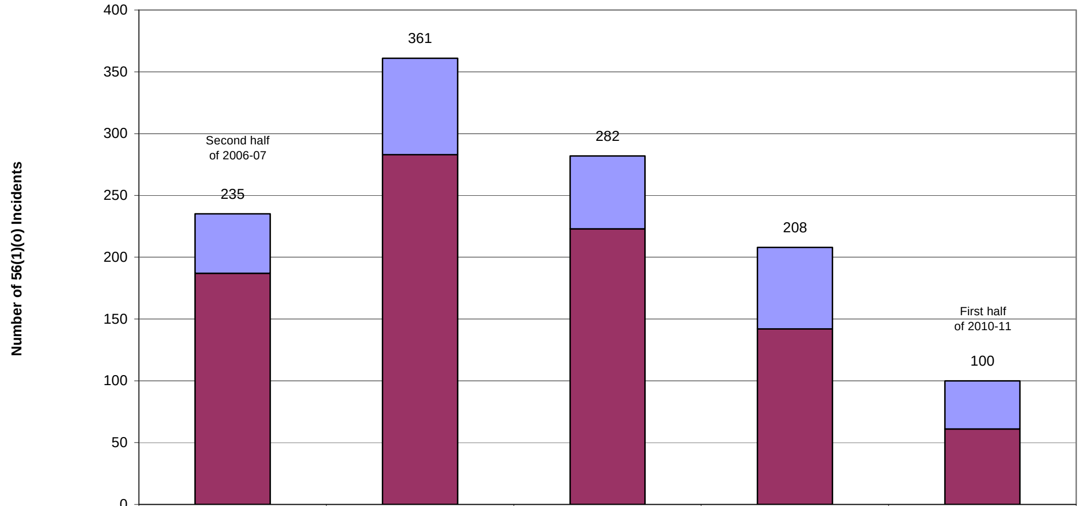
Figure 4
56(1)(o) Escape of Fluid Incidents by Quarter and Area Jan 2007 to Dec 2010



	2006-07, Qtr 3	2006-07, Qtr 4	2007-08, Qtr 1	2007-08, Qtr 2	2007-08, Qtr 3	2007-08, Qtr 4	2008-09, Qtr 1	2008-09, Qtr 2	2008-09, Qtr 3	2008-09, Qtr 4	2009-10, Qtr 1	2009-10, Qtr 2	2009-10, Qtr 3	2009-10, Qtr 4	2010-11, Qtr 1	2010-11, Qtr 2
North East Area	19	29	32	13	15	18	14	22	9	14	18	6	17	25	20	19
South East Area	124	63	115	36	41	91	62	58	50	53	45	30	33	34	31	30
Total	143	92	147	49	56	109	76	80	59	67	63	36	50	59	51	49

3.4 56(1)(o) Escape of Fluid Incidents by Financial Year

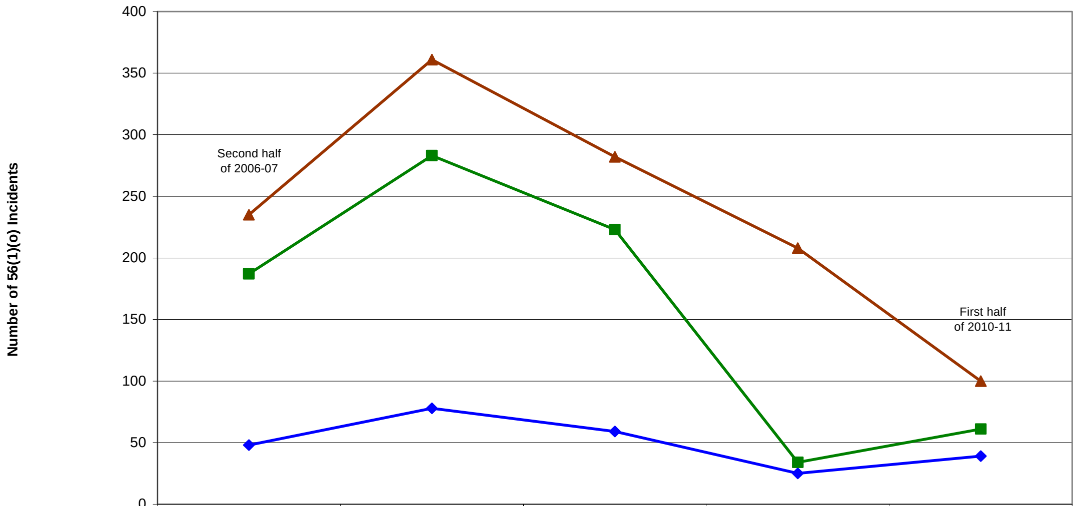
Figure 5
56(1)(o) Escape of Fluid Incidents by Financial Year Jan 2007 to Dec 2010



	2006-07 (Qtr 3, 4)	2007-08	2008-09	2009-10	2010-11 (Qtr 1, 2)
North East Area	48	78	59	66	39
South East Area	187	283	223	142	61
Total	235	361	282	208	100

Financial Year

Figure 6
56(1)(o) Escape of Fluid Incidents by Financial Year and Area Jan 2007 to Dec 2010



	2006-07 (Qtr 3, 4)	2007-08	2008-09	2009-10	2010-11 (Qtr 1, 2)
North East Area	48	78	59	25	39
South East Area	187	283	223	34	61
Total	235	361	282	208	100

Financial Year

3.5 56(1)(o) Escape of Fluid Incidents by Location

Note that the hoses / hydraulic components on a longwall by volume are 1000 times more than those in a development unit, the charts below will have more significance.

Figure 7
56(1)(o) Escape of Fluid Incidents by Incident Location Jan 2007 to Dec2010

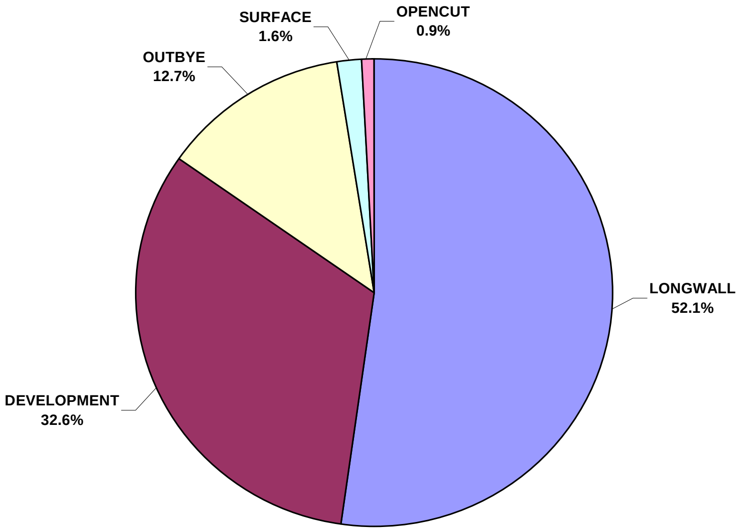
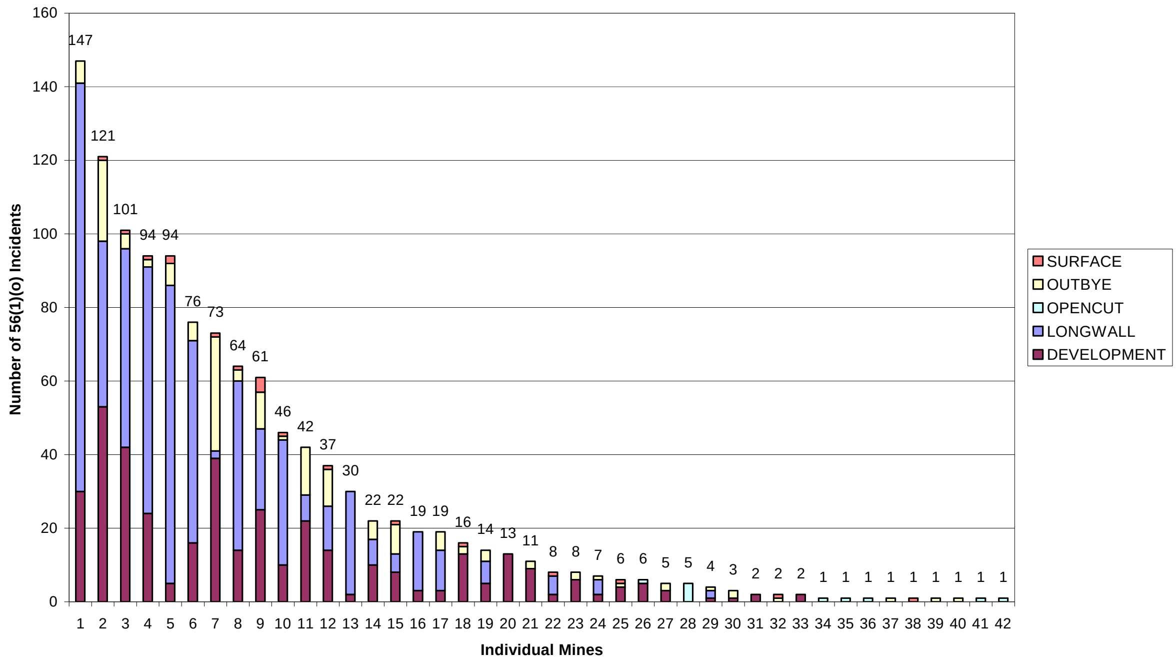


Figure 8
56(1)(o) Escape of Fluid Incidents by Mine and Incident Location Jan 2007 to Dec 2010



3.5.1 Longwall Escape of Fluid Incidents

The most common cause of escape of fluid over the last four years is hose failures mostly located on the shields (roof supports) on longwalls. Of these failures nearly 38.7% occurred on the leg circuit (leg raise set or leg lower). This hydraulic circuit has high number of cycles per push, necessary to ensure a high level of maintenance integrity of the leg circuit. In addition the legs are also loaded up from the roof strata.

The most common cause of failure is external physical damage, rubbing on steel or hoses and staples, struck by rock and coal, crushed hoses.

From previous studies the DA Ram circuit and the leg circuit are the two circuits with the high frequency cycles on longwall's. The lesson here is failure mode caused by environment, system pulse and overload. The DA Ram has external forces acting on it induced from bank push and the other roof supports.

The main cause of hydraulic hose failure is environmental damage, e.g. corrosion, abrasion, cuts, worn, wear and tear. Damaged hoses will not generally last to their rated fatigue life.
A latent condition comes from poor installation and poor hose support which allows some of the above failure modes to occur.

Staple-related issues account for 5.6% of incidents (34 incidents). One third of the staple related incidents appear to be human error where the people have not installed the staple and then re-powered. Mines should consider staple retention of some description (e.g. plate, cover, tie strap and tape). This needs to be considered at the design stage. On existing equipment this area can be improved. The use of a retention device will assist in preventing human error as the people will have to inspect the staple and hose end before installing the staple retention method.

NOTE:- Some mines have changed from square staples to a "D " shaped staple which are reported to have longer fatigue life and improved retention.
The ultimate aim is to change to a hose connection that eliminates staples.

Consideration should be given to the types of human error which is experienced in these incidents. Risk controls are required to be put in place to account for possible human error.
A recent incident where an employee was replacing hoses and then called away to another task and left hoses in a dangerous condition. When working on high pressure hydraulics it is important to leave the workplace in a safe condition if called away.
Testing and commissioning of high pressure hydraulics need to be carried out from a safe location (e.g. from say 3 shields away using adjacent controls).

Figure 9
56(1)(o) Escape of Fluid Incidents on Longwalls by Failed Equipment Jan 2007 to Dec 2010

Longwall Failed Equipment	No of Incidents	Percentage
Hose Failures	363	59.8%
Isolation Issues	17	2.8%
Human Error	11	1.8%
Fitting Failures	25	4.1%
Staple Related	34	5.6%
"O" Ring Failure (on valves etc)	49	8.1%
Yield Valves	8	1.3%
Leg Cylinder Failures	6	1.0%
Base Lift Ram Failures	1	0.2%
DA Ram Failures	2	0.3%
Stabiliser Cylinder / Compensation Ram Failure	2	0.3%
Monorail Area	15	2.5%
BSL Area	5	0.8%
Pump Station	6	1.0%
Duplicated i.e. multiple people + 3 & multiple injuries = 5 Total = 8	8	1.3%
Undeterminable (e.g. Burst hose – worn)	55	9.1%
Total	**607**	**100.0%**

Figure 10
56(1)(o) Escape of Fluid Incidents on Longwalls due to Hose Failures by Cause of Failure Jan 2007 to Dec 2010

Longwall Hose Failure Cause	No of Incidents	Percentage
To tight bend radius on hose	22	6.1%
Worn out / fatigued	45	12.4%
External Physical Damaged	120	33.1%
Corrosion	21	5.8%
Undeterminable (e.g. Burst hose – worn)	55	15.2%
Insufficient information	100	27.5%
Total	**363**	**100.0%**

Figure 11
56(1)(o) Escape of Fluid Incidents on Longwalls due to Hose Shield Failures by Location Jan 2007 to Dec 2010

Longwall Hose Shield Failure Location	No of Incidents	Percentage
Leg Circuit	94	38.7%
DA Ram Circuit	34	14.0%
High pressure Set / Posi set circuit	21	8.6%
Base Lift	40	16.5%
Flipper / side shield hoses	35	14.4%
Interchock Hoses	19	7.8%
Total	**243**	**100.0%**

3.5.2 Development Unit Escape of Fluid Incidents

One specific hose group which fails prematurely is the underground coal drill rig bonded motor hoses. (i.e. 4 hose set from the stationary manifold on the drill mast to the drill rig motor). Failure modes of this hose set are that the bend radius is too tight, unsuitable hose length, and physical hose damage from coal on the floor when the motor is left in the retracted position when the machine is tramming.

Mines are replacing this set of hoses on a 4- to 6-weekly basis, to prevent hose failures.

Guards should be installed on both ends of this hose set to cover the area from the connection to 100mm past the ferrule.

Figure 12
56(1)(o) Escape of Fluid Incidents in Development Units by Failed Equipment Jan 2007 to Dec 2010

Development Units Failed Equipment	No of Incidents	Percentage
Hoses	129	33.1%
Head Shear Jack area	5	1.3%
Fittings	20	5.1%
"O" rings	13	3.3%
Isolation	2	0.5%
Cable Bolt Tensioner	8	2.1%
Drill Rigs (Roof)	86	22.1%
Rib Bolters	11	2.8%
Staples	2	0.5%
Swing Cylinder	2	0.5%
Human Error	1	0.3%
Insufficient information	111	28.5%
Total	**390**	**100.0%**

Figure 13
56(1)(o) Escape of Fluid Incidents in Development Units due to Hose Failure by Cause of Failure Jan 2007 to Dec 2010

Development Units Hose Failure Cause	No of Incidents	Percentage
External Damage (worn, caught, hit)	30	23.3%
Worn out Fatigue	10	7.8%
Wear & Tear	4	3.1%
Bend Radius	3	2.3%
Hose to Long	2	1.6%
Corrosion	1	0.8%
Insufficient information	79	61.2%
Total	**129**	**100.0%**

Figure 14
56(1)(o) Escape of Fluid Incidents in Development Units due to Drill Rigs (Roof) Failure by Cause of Failure Jan 2007 to Dec 2010

Development Units Drill Rigs (Roof) Failure Cause	No of Incidents	Percentage
Motor bonded hose pack	39	45.3%
Timber Jack hoses	5	5.8%
Other hoses identified	8	9.3%
Insufficient information	34	39.5%
Total	**86**	**100.0%**

Figure 15
56(1)(o) Escape of Fluid Incidents in Development Units due to Hose Failure by Cause of Failure Jan 2007 to Dec 2010

Development Units Rib Bolters Failure Cause	No of Incidents	Percentage
Motor bonded hoses	4	36.4%
Insufficient information	7	63.6%
Total	**11**	**100.0%**

4 People Involved in 56(1)(o) Escape of Fluid Incidents

This section provides a breakdown of the people involved in 56(1)(o) escape of fluid incidents for the period from January 2007 to December 2010.

The people involved in 56(1)(o) escape of fluid Incidents fall into one or more of the following categories:

- the nature of injury is notifiable (ie fluid injection or serious burn)
- the outcome of the injury is notifiable (ie hospital inpatient admission or unfit for at least 7 days)
- the nature of injury is not notifiable (eg superficial, contusion etc)
- the outcome of the injury is not notifiable (eg first aid treatment)
- no injury resulted (ie nil treatment)

For the 4 year period from January 2007 to December 2010, there were:

- 152 people were involved in 1,186 incidents of 56(1)(o) fluid escapes
- **5 people received fluid injection injuries** – *Refer to Section 4.2.1 55(a)(v) Fluid Injection Injuries*
- **1 person received a serious burn injury** – *Refer to Section 4.2.3 55(c)(v) Serious Burn Injuries*
- 86 people were sent to hospital, of whom 15 were admitted as an inpatient
- 31 people received first aid on site and 14 were treated in a doctor’s surgery
- 10 people were unfit for at least 7 days
- 16 people received nil treatment

There were 4 incidents where multiple persons were involved:

- 1 incident with 3 people involved on a longwall face.
- 1 incident with 2 people underground outbye services.
- 1 incident with 2 people in an underground development unit on a miner.
- 1 incident with 2 people in an underground mine on the longwall.

The most likely area for people to be struck with fluid is around the hands/fingers, face and arm/forearm areas. This is reflected in both the 4 year period and the last 12 months and is consistent with people working on or in close proximity to hydraulic failures.

4.1 People Involved in 56(1)(o) Escape of Fluid Incidents

Figure 16
People Involved in 56(1)(o) Escape of Fluid Incidents Jan 2007 to Dec 2010

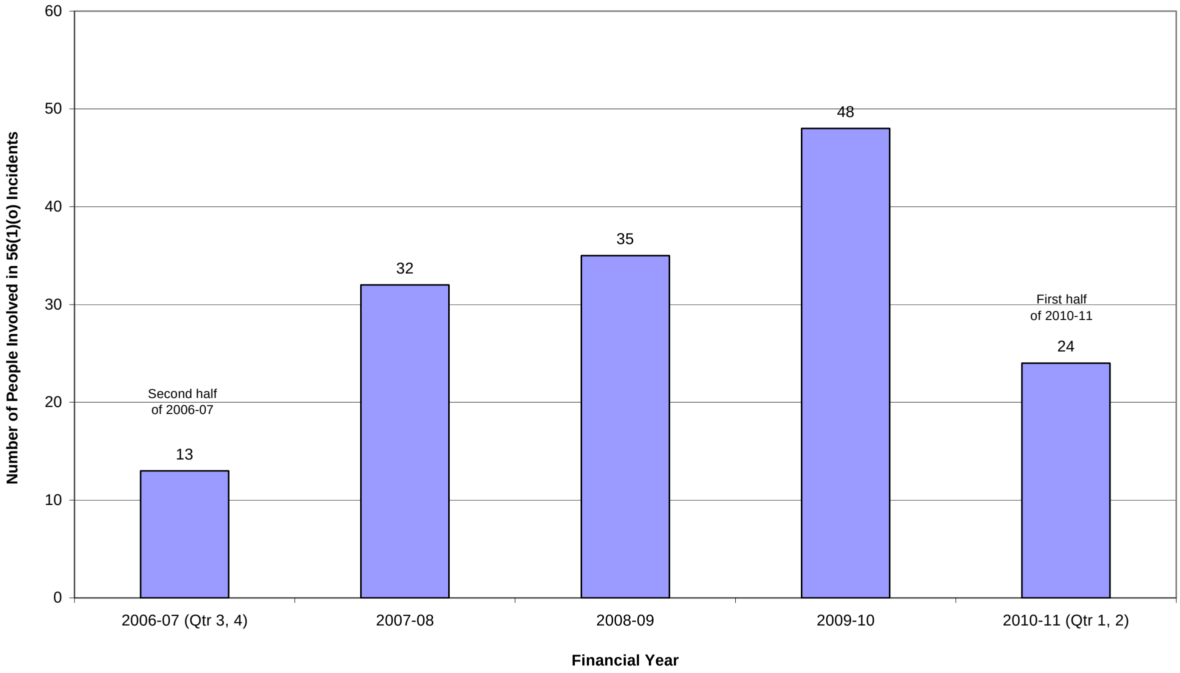
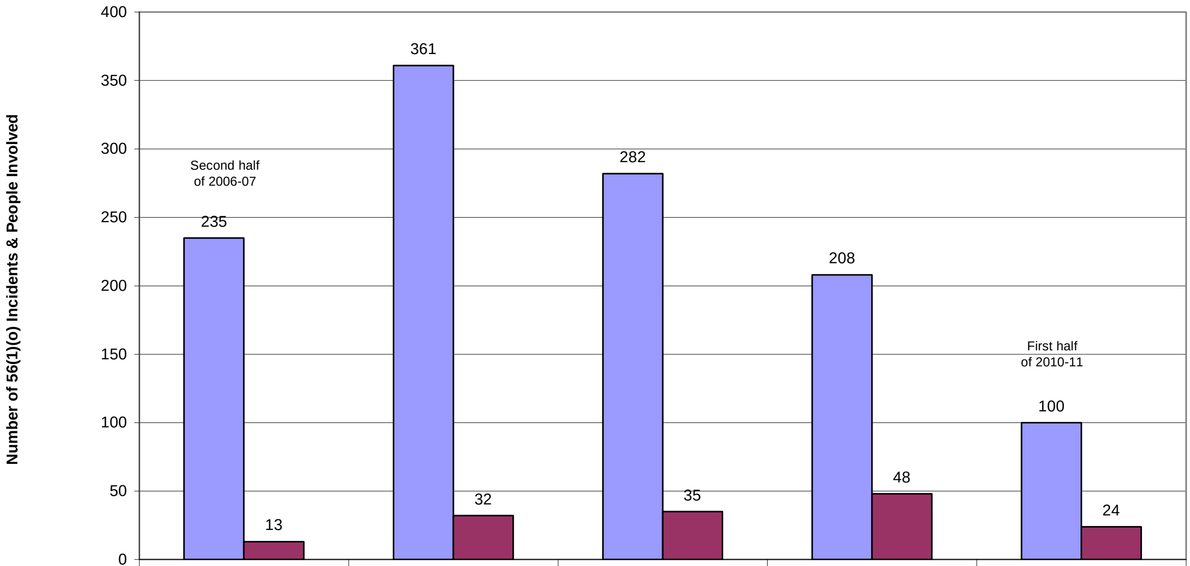


Figure 17
People Involved in 56(1)(o) Escape of Fluid Incidents and Number of Incidents Jan 2007 to Dec 2010



	2006-07 (Qtr 3, 4)	2007-08	2008-09	2009-10	2010-11 (Qtr 1, 2)
Incidents	235	361	282	208	100
Injuries	13	32	35	48	24

Financial Year

4.2 People Involved in 56(1)(o) Escape of Fluid Incidents by Nature of Injury

Figure 18

People Involved in 56(1)(o) Escape of Fluid Incidents by Nature of Injury Jan 2007 to Dec 2010

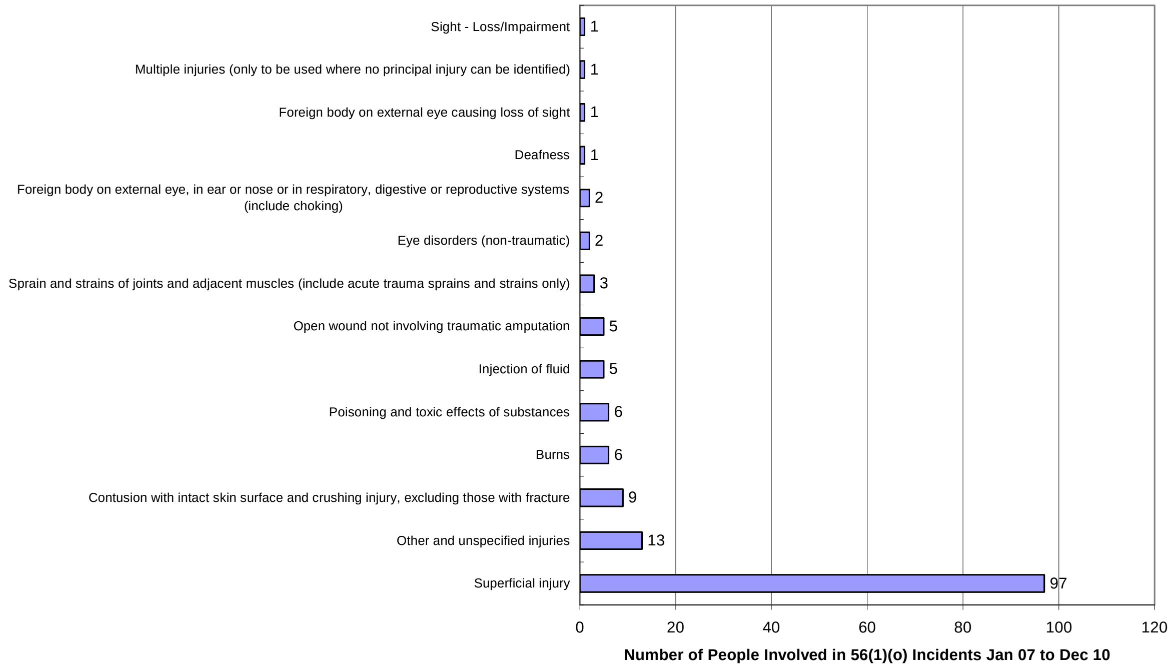
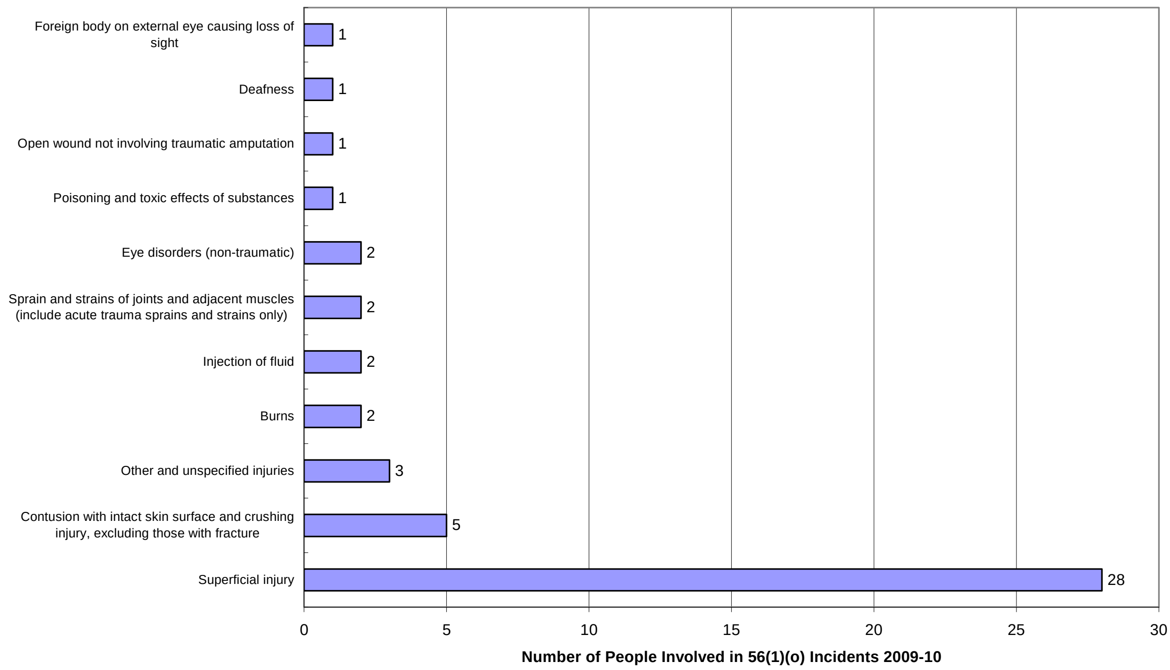


Figure 19

People Involved in 56(1)(o) Escape of Fluid Incidents by Nature of Injury 2009-10



4.2.1 55(a)(v) Fluid injection Injuries

During the 4 year period from January 2007 to December 2010, there were 5 fluid injection injuries notified under *CMHSR 2006, Clause 55(a)(v) injection of fluid (including hydraulic fluid, oil air or water) under pressure*.

Four of these injuries occurred at underground coal mines (one of these at its coal handling plant) and one occurred at an open cut operation.

Figure 20
55(a)(v) Fluid Injection Injuries in 56(1)(o) Escape of Fluid Incidents Jan 2007 to Dec 2010

Year	Underground	Open Cut	Total
2007	1	-	**1**
2008	1	1	**2**
2009	1	-	**1**
2010	1	-	**1**
Total	**4**	**1**	**5**

<u>Circumstances of 56(1)(o) Escape of Fluid Incidents with 55(a)(v) Fluid Injection Injuries</u>

1. A Brain pump blockage in the delivery line and air pressurised, releasing fluid pressure which struck a person in the leg. (Deputy, Permanent employee, pumping duties).

2. Coal Handling Plant: A painter was cleaning an airless spray gun which injected fluid into his finger. (Painter [Operator] Contractor employee, surface painting duties, injected in finger).

3. Development unit employees were cable bolting and the cable bolt tensioner pipe ruptured due to intensification. (Contractor employee Supervisor, Secondary Bolting operations, struck in the hand – fingers)

4. Longwall unit a staple was removed from a pressurised inter chock hose which released fluid injecting the employee in his hand. (Fitter, maintenance duties, hand)

5. Open Cut: A contractor was cleaning equipment using pressure water cleaner and he cleaned the blocked nozzle with his hand which injected water into his finger. (Contractor, cleaning operations, injected in finger).

All of the above incidents were classified by I&I NSW as *Investigation Level 2 – Official to attend mine*.

4.2.2 55(c)(v) Serious Burn Injuries

During the 4 year period from January 2007 to December 2010, there was 1 serious burn injury notified under *CMHSR 2006 Clause 55(c)(v)serious burns to a person that present an immediate threat to life or of permanent incapacitating injury*

<u>Circumstances of 56(1)(o) Escape of Fluid Incident with 55(c)(v) Serious Burn Injury</u>

1. Open Cut using Oxy cutting pin & hot fluid escaped injuring the employee.

4.2.3 Other Injuries

While during both the 4 year period from January 2007 to December 2010 and the last 12 months, the nature of injury for the majority of people involved in 56(1)(o) Escape of Fluid Incidents were *superficial*, *contusion with intact skin surface* or *other and unspecified,* there were some significant injuries.

<u>Circumstances of 56(1)(o) Escape of Fluid Incident with suspected Fluid Injection Injury</u>

1. Electrician noticed the belt tracking off and coal spillage at the boot. Electrician powered up the bootend when hydraulic oil was released from under the belt lift cylinder "piano key" valve, hitting him in the left forearm. Injury was treated as a suspected fluid injection, however no fluid injection had occurred as confirmed by minor surgery.

4.3 People Involved in 56(1)(o) Escape of Fluid Incidents with Notifiable Injury Outcomes

Figure 21
People Involved in 56(1)(o) Escape of Fluid Incidents with Notifiable Injury Outcomes Jan 2007 to Dec 2010

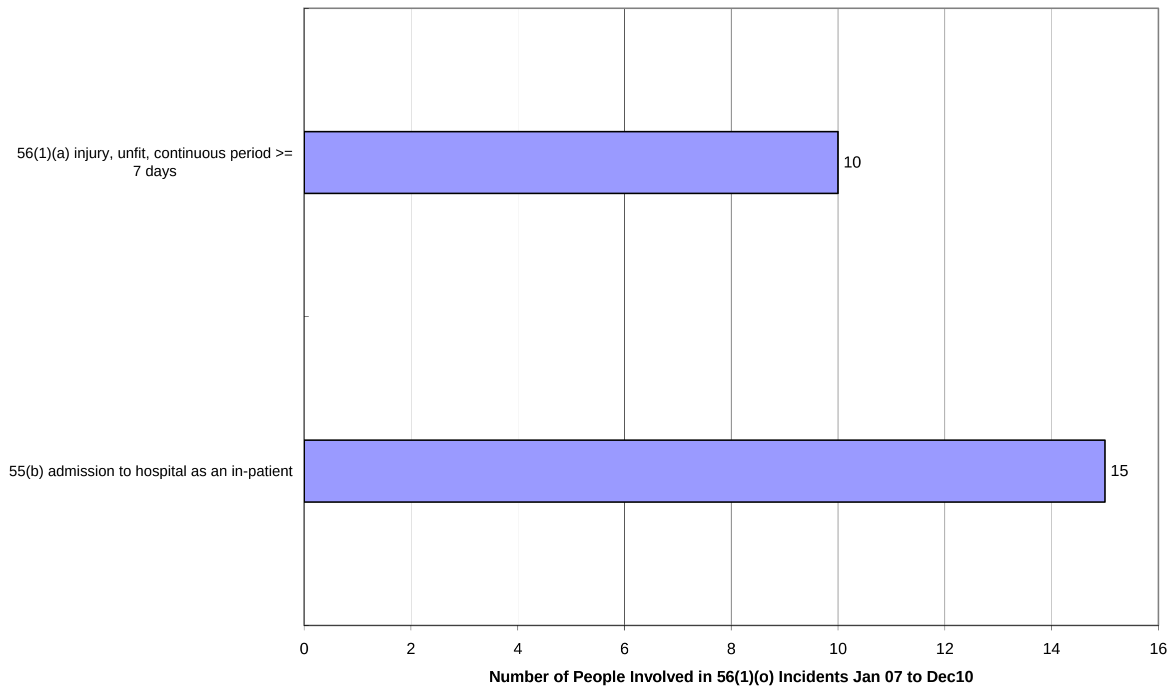
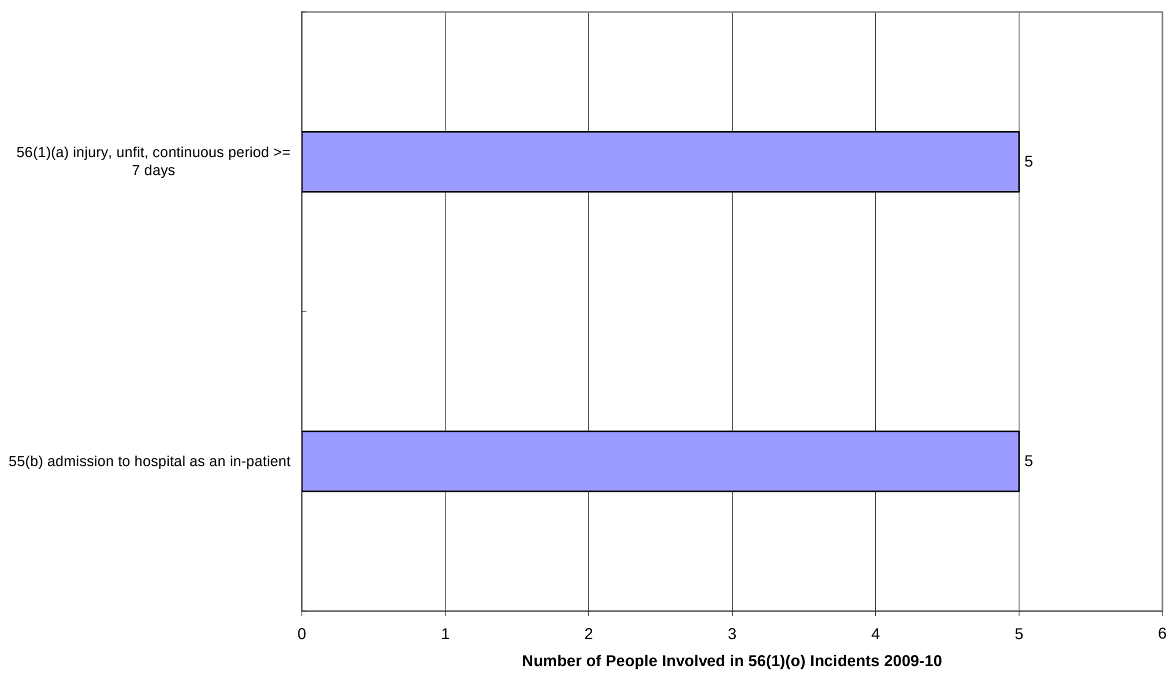


Figure 22
People involved in 56(1)(o) Escape of Fluid Incidents with Notifiable Injury Outcomes 2009-10



4.4 People Involved in 56(1)(o) Escape of Fluid Incidents by Treatment

Figure 23
People Involved in 56(1)(o) Escape of Fluid Incidents by Treatment Jan 2007 to Dec 2010

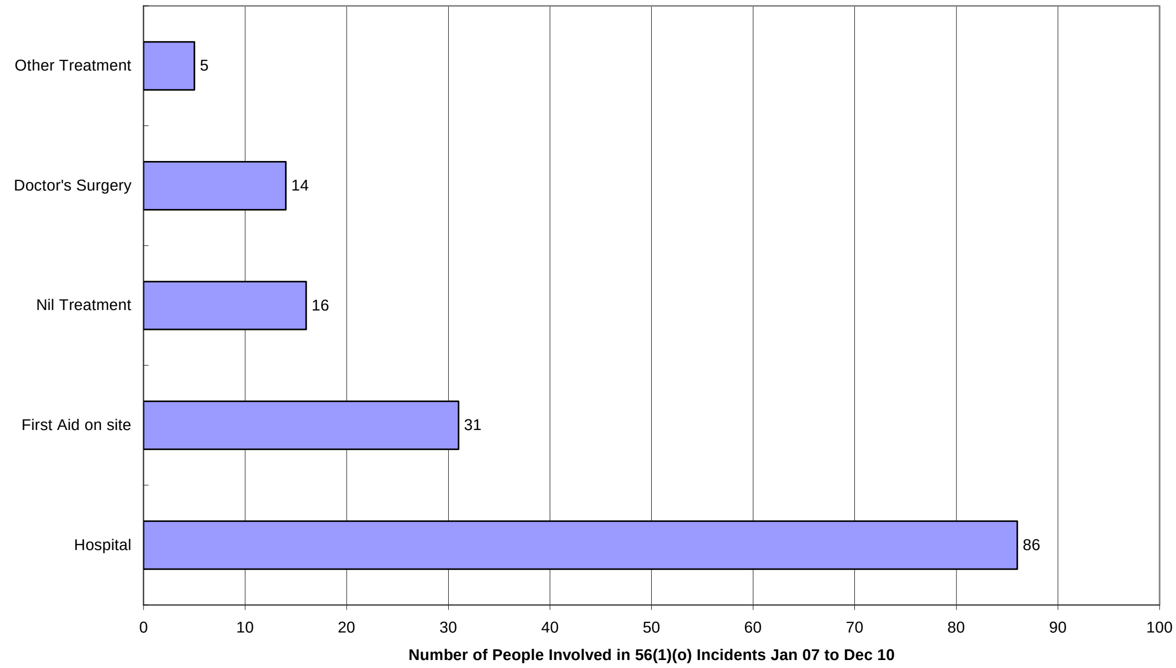
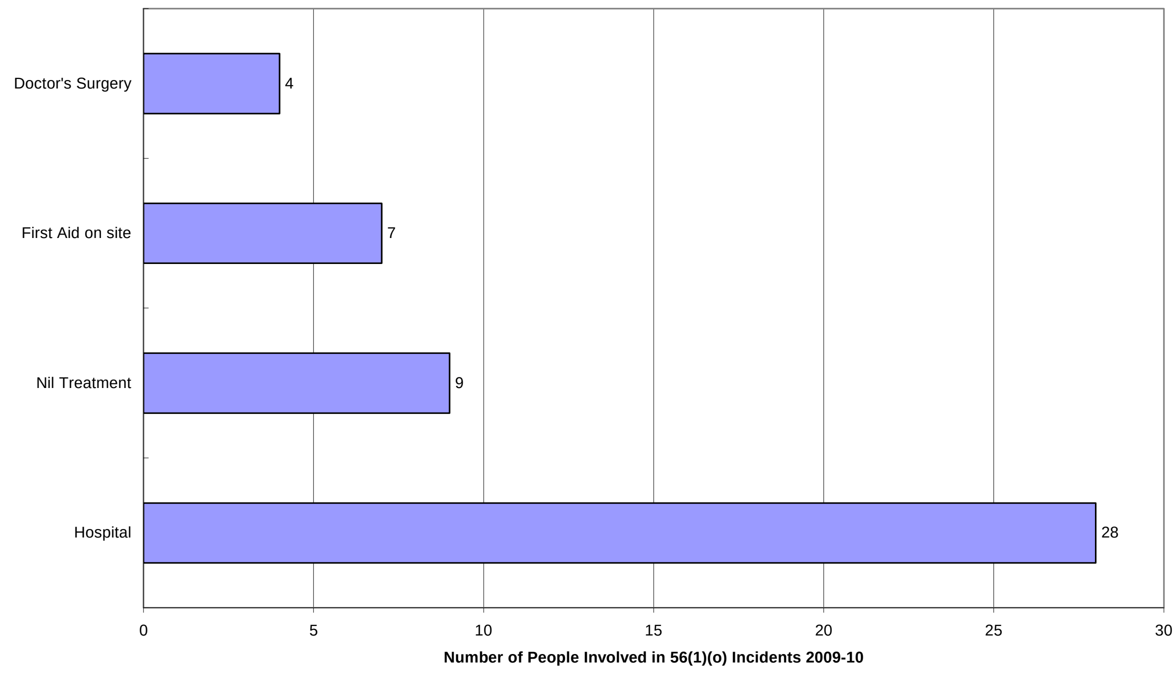


Figure 24
People involved in 56(1)(o) Escape of Fluid Incidents by Treatment 2009-10



4.5 People Involved in 56(1)(o) Escape of Fluid Incidents by Bodily Location

Figure 25
People Involved in 56(1)(o) Escape of Fluid Incidents by Bodily Location Jan 2007 to Dec 2010

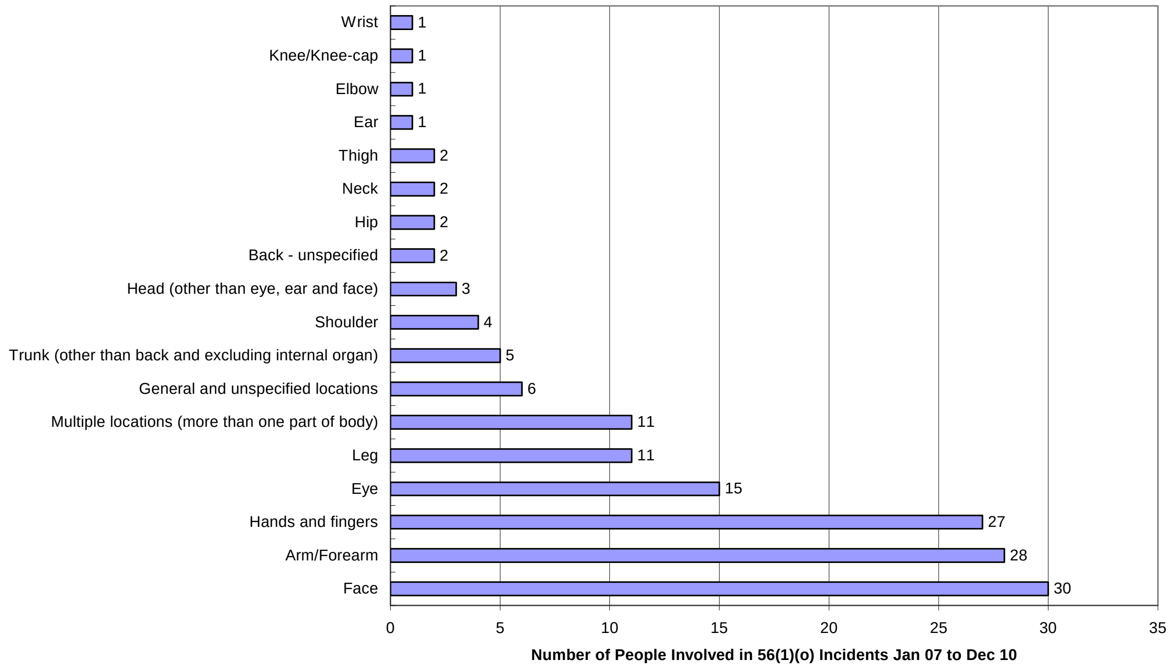
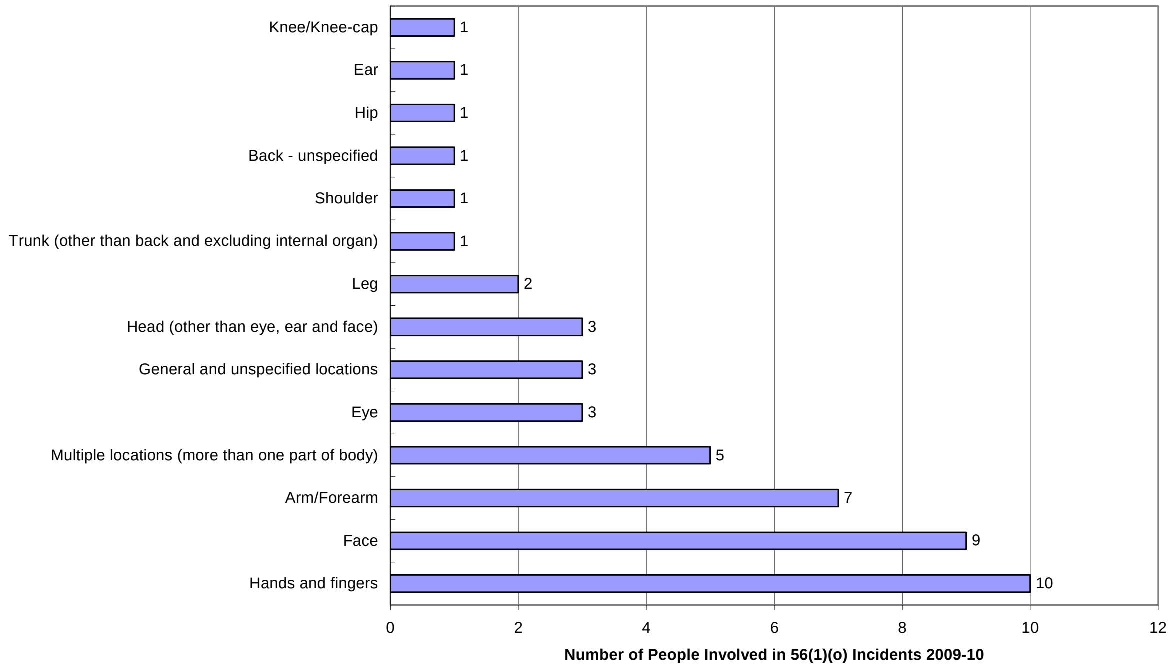


Figure 26
People Involved in 56(1)(o) Escape of Fluid Incidents by Bodily Location 2009-10



4.6 People Involved in 56(1)(o) Escape of Fluid Incidents by Mechanism

Figure 27

People Involved in 56(1)(o) Escape of Fluid Incidents by Mechanism Jan 2007 to Dec 2010

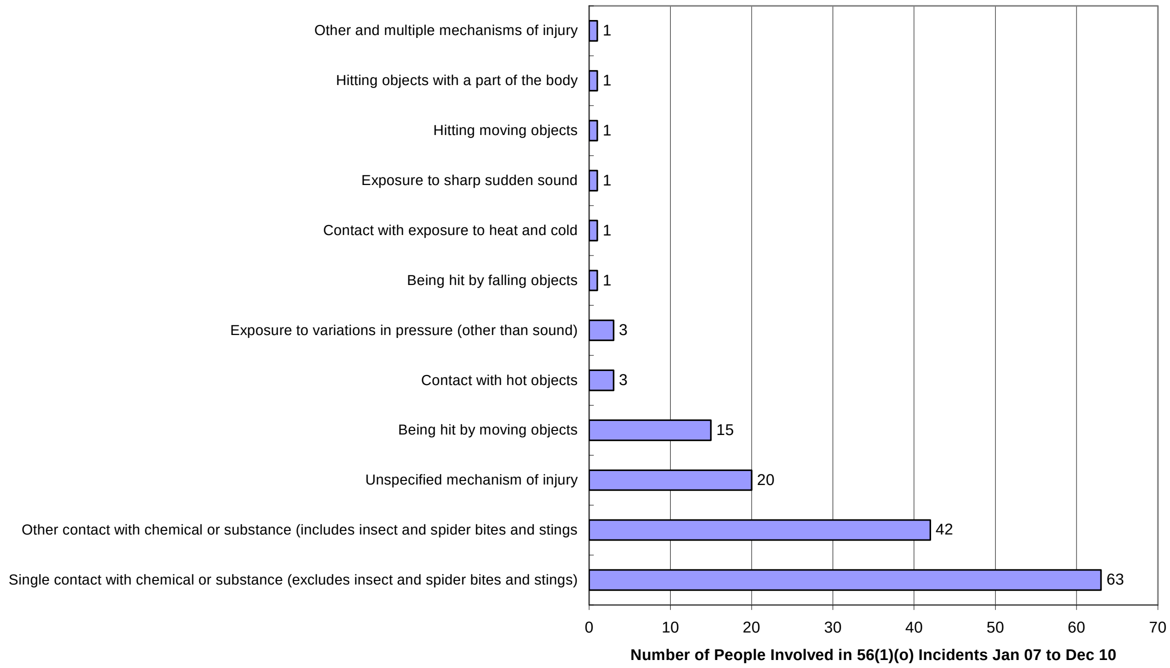
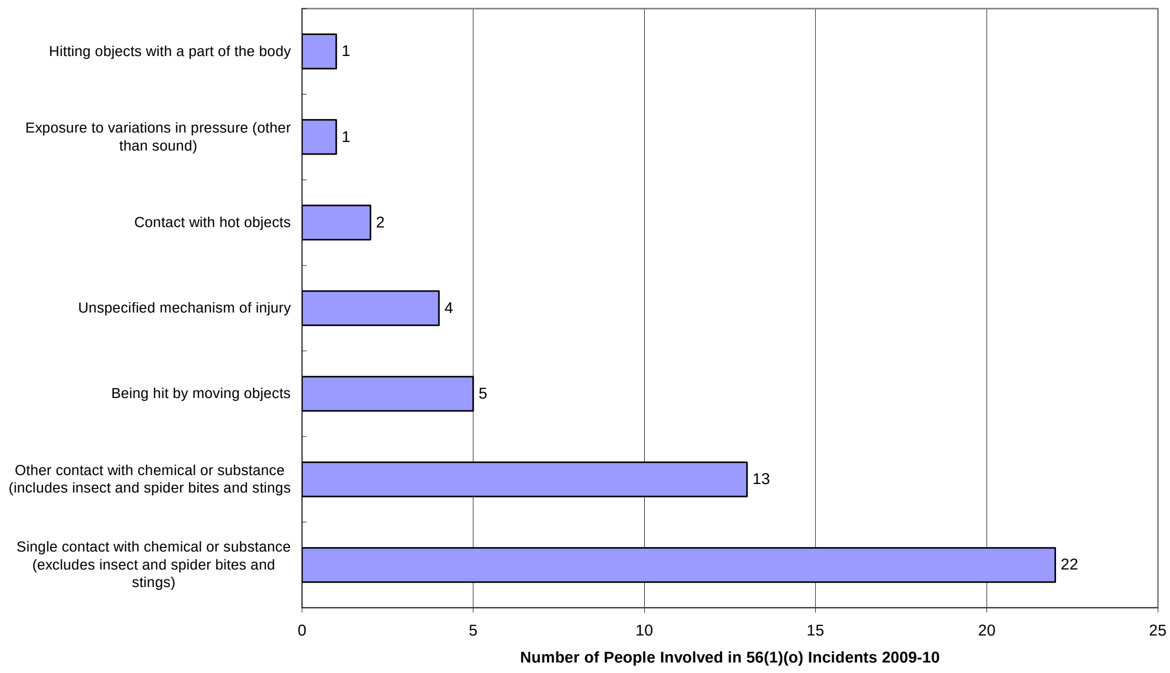


Figure 28

People Involved in 56(1)(o) Escape of Fluid Incidents by Mechanism 2009-10



4.7 People Involved in 56(1)(o) Escape of Fluid Incidents by Agency

Figure 29
People Involved in 56(1)(o) Escape of Fluid Incidents by Agency Jan 2007 to Dec 2010

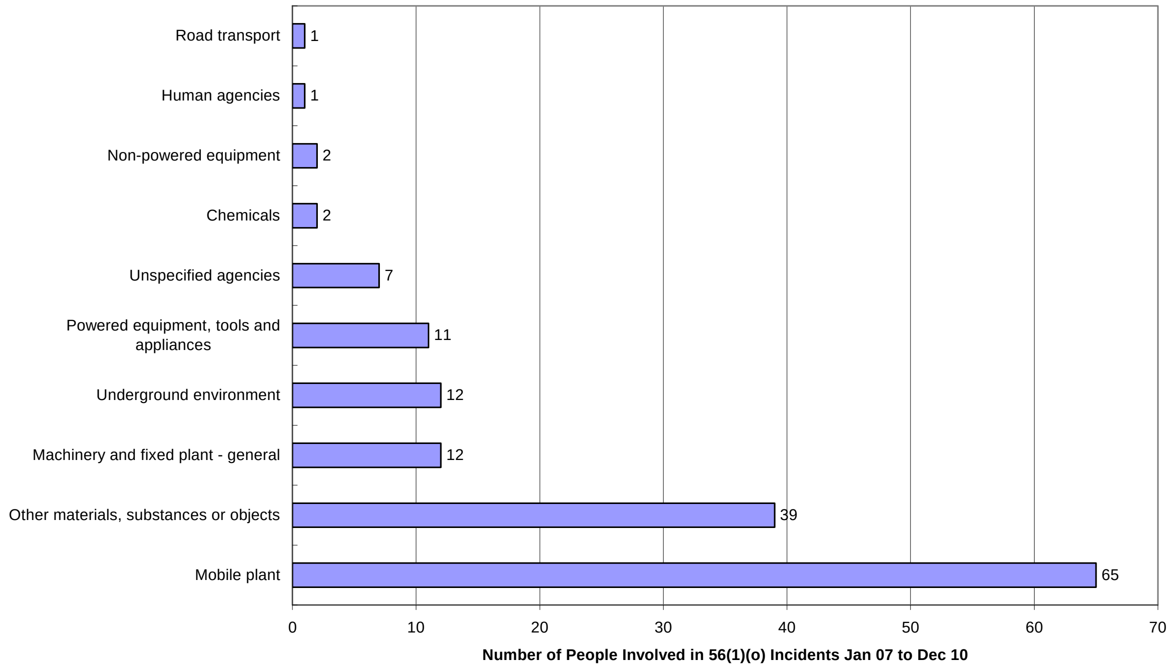
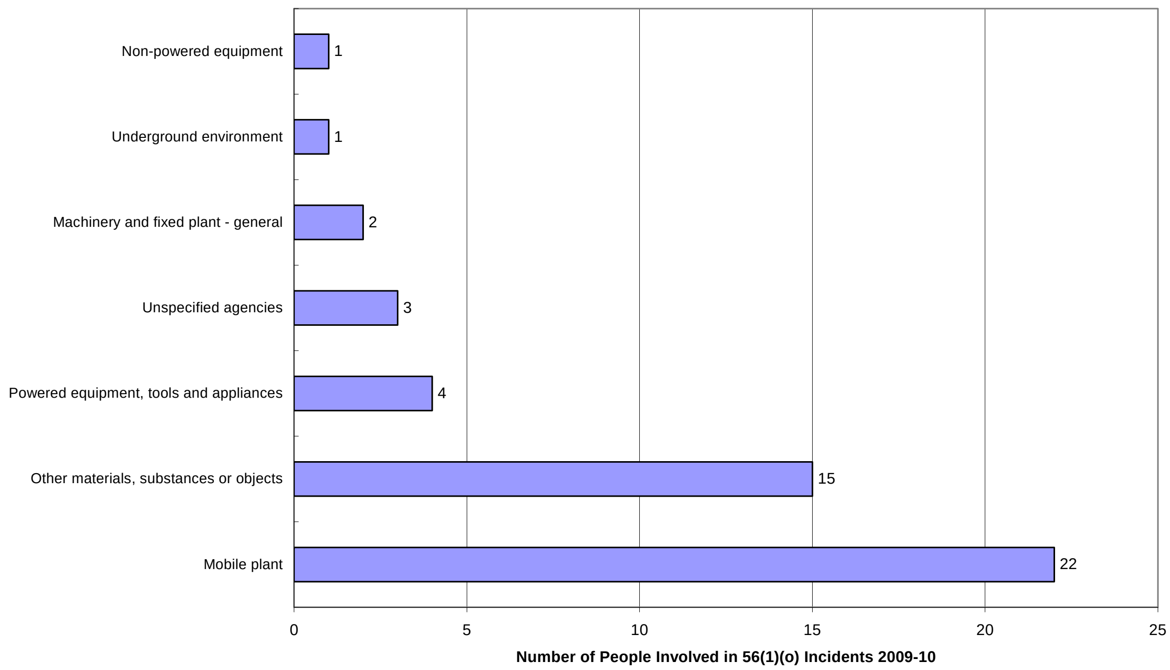


Figure 30
People Involved in 56(1)(o) Escape of Fluid Incidents by Agency 2009-10



4.8 People Involved in 56(1)(o) Escape of Fluid Incidents by Employment Type

Figure 31
People Involved in 56(1)(o) Escape of Fluid Incidents by Employment Type Jan 2007 to Dec 2010

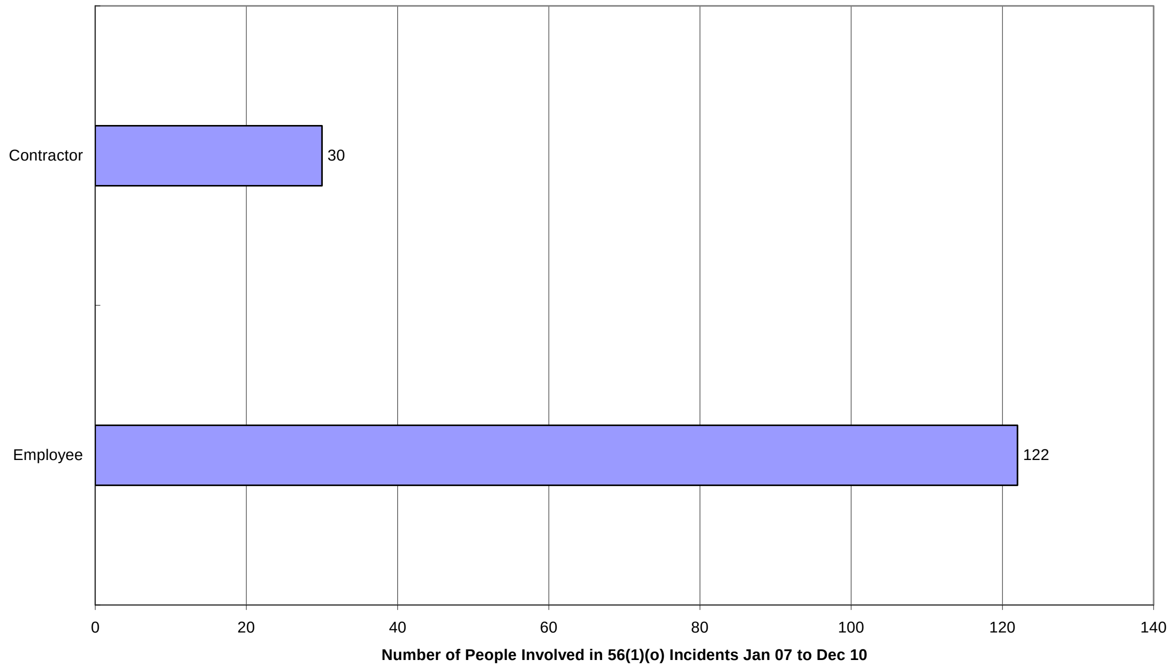
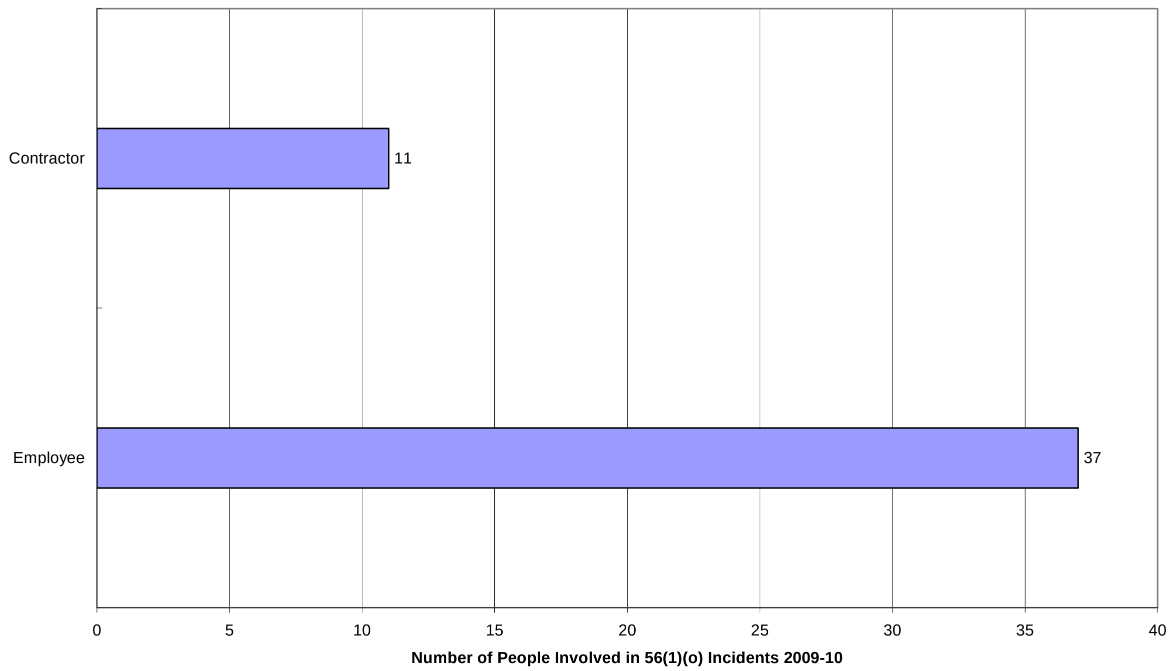


Figure 32
People Involved in 56(1)(o) Escape of Fluid Incidents by Employment Type 2009-10



4.9 People Involved in 56(1)(o) Escape of Fluid Incidents by Employment Role and Category

Figure 33
People Involved in 56(1)(o) Escape of Fluid Incidents by Injured Person's Employment Role Jan 2007 to Dec 2010

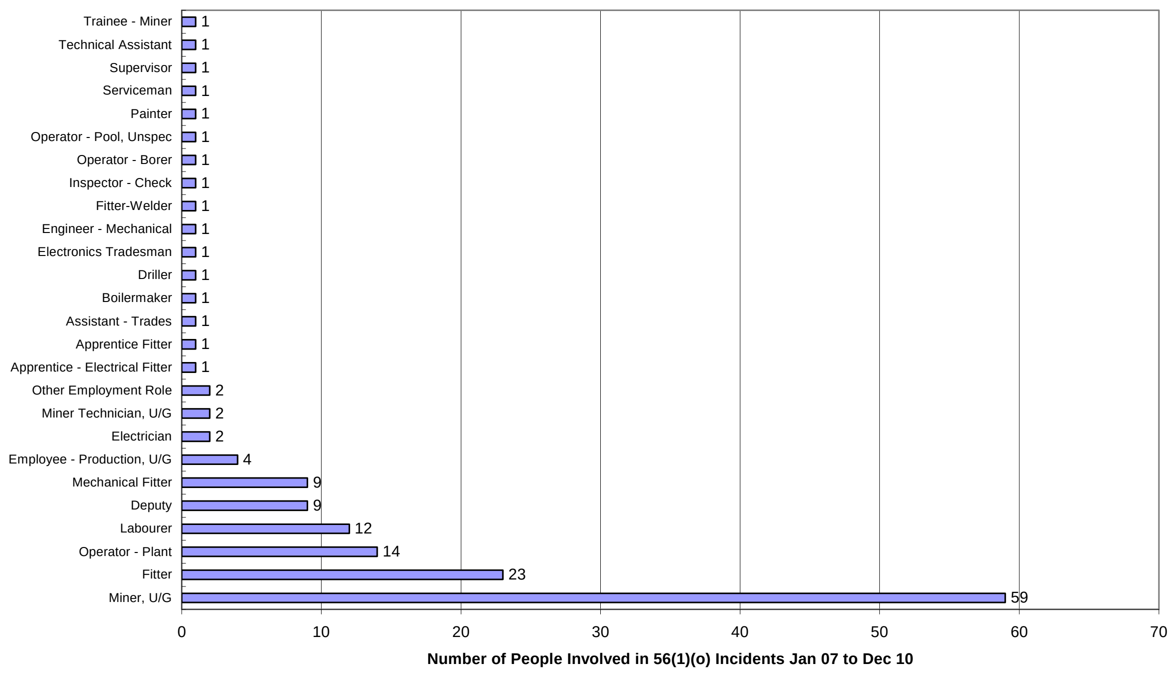
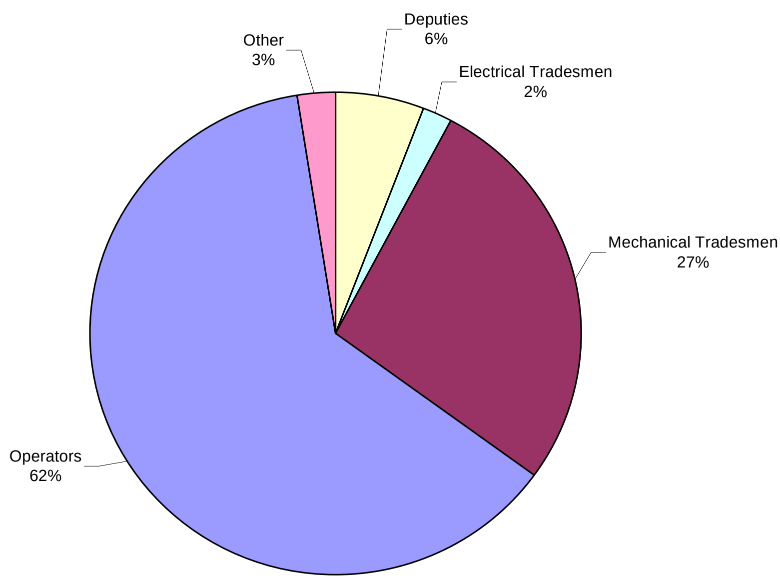


Figure 34
People Involved in 56(1)(o) Escape of Fluid Incidents by Injured Person's Employment Category Jan 2007 to Dec 2010



APPENDIX A ADDITIONAL INFORMATION

Figure 35
Hazard Levels Relative to Pressure Equipment (Refer AS4343-2005)

Hazard on normal production refer to pressure std pV = Hazard x Exp

Location	Pressure Psi (Bar)	Flow	pV/min Mpa.l/min	pD Mpa.mm	No of Hoses est	Hazard Level	Exposure man/shift
Longwall Nominal	4600 psi (320-350 Bar) – 6100 psi (420 Bar)	1200 - 1600 l/min	38400 – 56000	50mm = 1750 "B"	35000	B	All shift on production & maintenance HIGH
Development	2500 psi (172 Bar) – 3000 psi (206 Bar)	90 l/min	1548	32mm = 640 "D"	30	D	All shift on production/bolting HIGH
Outbye	2500 psi (172 Bar) - 3000 psi (206 Bar)	40 l/min	516		10	E	When Equipment LHD operating MEDIUM
Surface	3000 psi (206 Bar) – 4000 psi (275 Bar)	20 l/min	412 - 550		16	E	LOW
Open Cut	2500 psi (172 Bar) – 3500 psi (240 Bar)	Est 90 l/min	1548		0	D	Not generally exposed during production LOW

(The above figures for pressure and flow etc are sourced from mine engineers and may be specific to their equipment)

The above table is a representation of the Hazard Levels relative to pressure equipment.

LOW → HAZARD LEVEL → HIGH

E	D	C	B	A

The above comparison represents the longwall system has a higher hazard level and a higher energy source that the other mine locations by a magnitude of 2 hazard levels higher.

If we consider the Risk = Hazard x Exposure we end up with the following:-

Location	Hazard x	Exposure =	Risk
Longwall	B	4	High
Development	D	4	Medium
Outbye	E	3	Low
Surface	E	2	Low
Open Cut	D	2	Medium

Figure 36
Hazard Levels Risk Matrix

	LOW		CONSEQUENCE		HIGH
People	Injuries or ailments not requiring medical treatment	Minor injury or first-aid treatment case	Serious injury requiring hospitalisation or multiple medical treatment cases	Life threatening injury or multiple serious injuries resulting in hospitalisation	Death or multiple life threatening injuries

LOW → HAZARD LEVEL → HIGH

Likelihood	Exposure	Likelihood	E	D	C	B	A
	5	Almost Certain	M	H	H	E	E
	4	Likely	M	M	H	H	E
	3	Possible	L	M	M	H	E
	2	Unlikely	L	M	M	H	H
	1	Rare	L	L	M	M	H

Risk: **E - Extreme** **H - High** **M - Medium** **L - Low**