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NSW Coal Mines
High Pressure Hydraulics
Incident Analysis

CMH&S Regulation 2006 Clause 56(1)(o)

an escape of fluid under pressure that could place any person at risk

4 Year Period from January 2007 to December 2010

MEMMES Seminar April 2011

Introduction

- 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.
- Inclusion of a new clause *56(1)(o)* in the *Coal Mines Health and Safety Regulation 2006* (CMHSR 2006) which requires mandatory notification of any "*escape of fluid under pressure that could place any person at risk*".
- 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.

Legislation – 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).*

Summary

- There were 1,186 escape of fluid incidents involving 152 people.
- 5 people sustained fluid injection injuries
- 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)

Summary cont

- The most likely mine location for an escape of fluid incident to occur is
  - longwall face (52%)
  - development units (33%)
  - outbye (13%)
  - surface (1.5%)
  - open cut (1%).

Number of Mines and 56(1)(o) Incidents

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

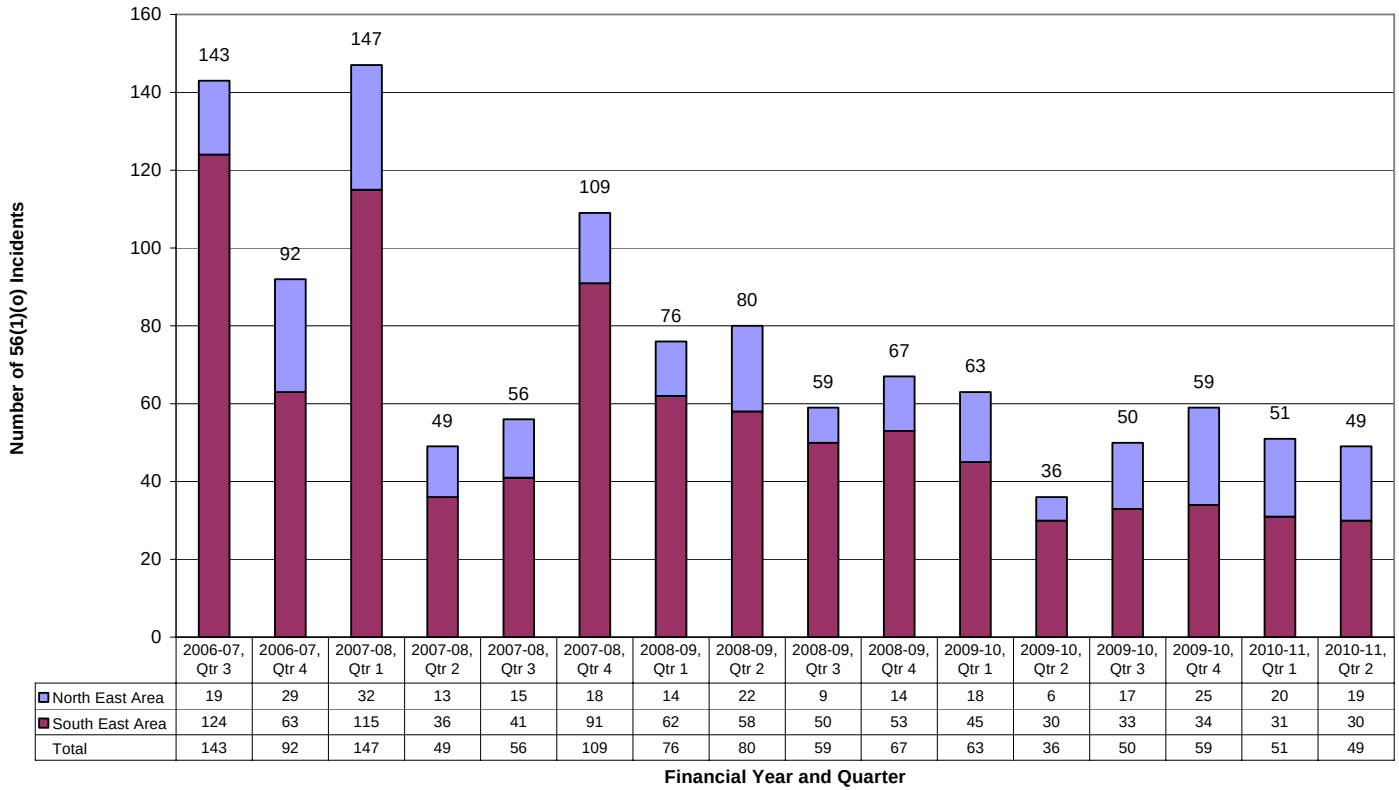
Area	Region	Underground	Surface		Exploration	Total
			Open Cut	Processing		
North East Area	Hunter	15	23	10	0	48
	Northern	1	5	2	1	9
	Total	16	28	12	1	57
South East Area	South Eastern	17	5	6	1	29
Total		**33**	**33**	**18**	**2**	**86**

- **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**

56(1)(o) 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

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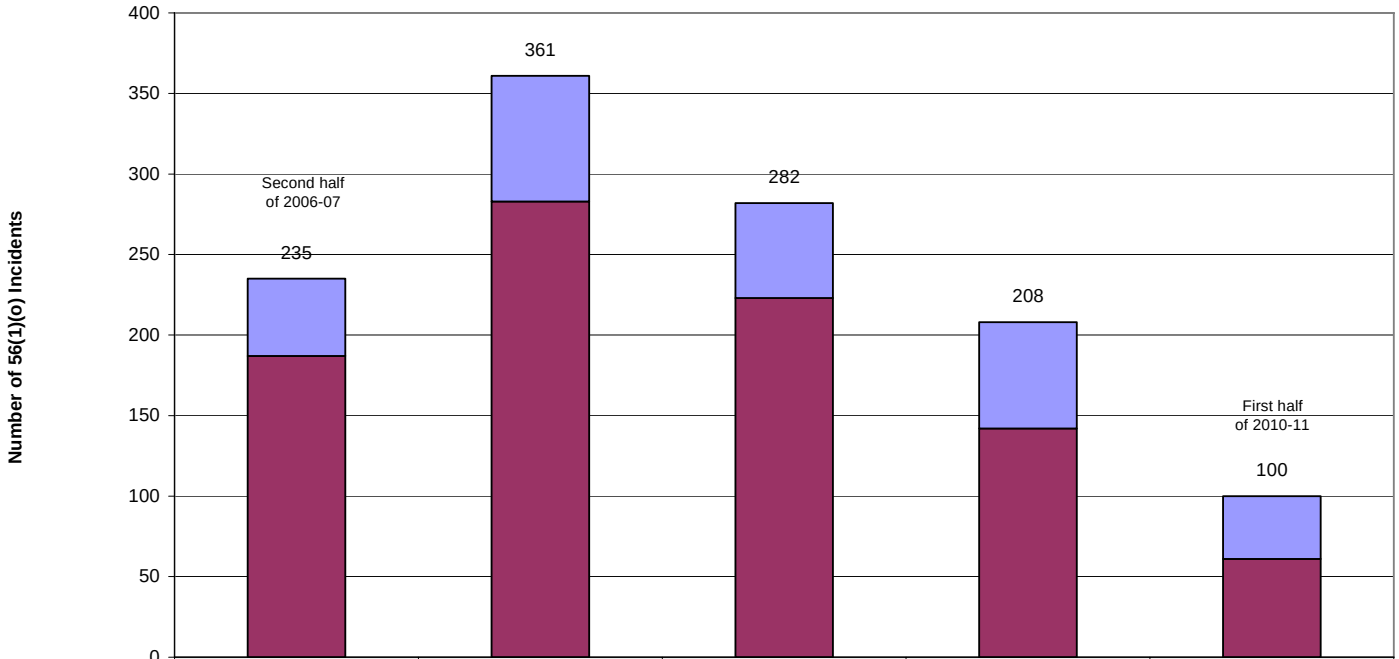
56(1)(o) Incidents by Financial Year

- **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

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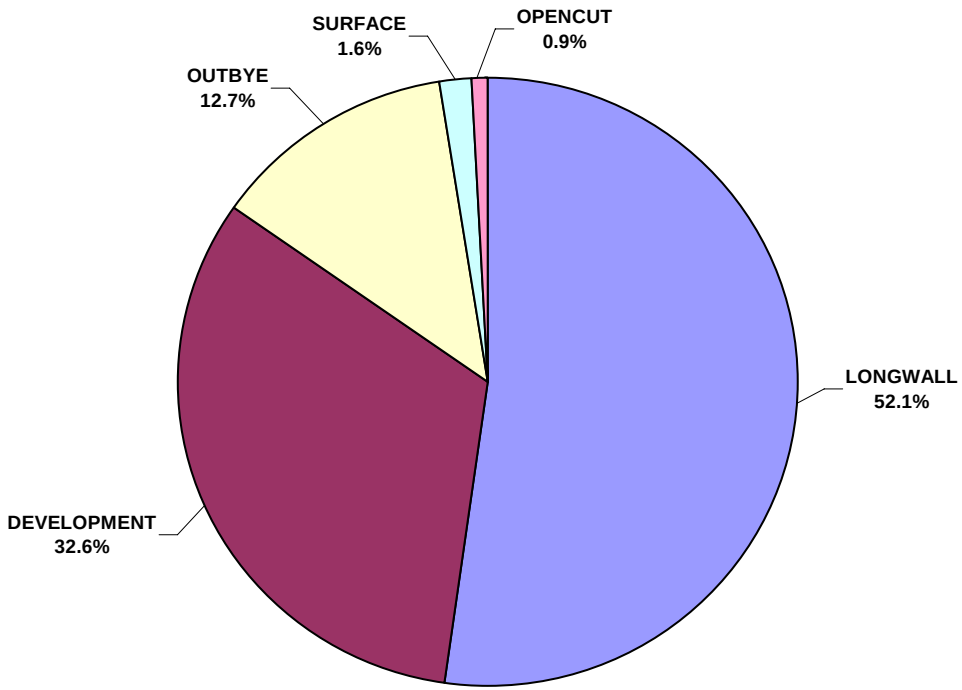
56(1)(o) Incidents by Location

- **Figure 7**
  56(1)(o) Escape of Fluid Incidents by Incident Location
  Jan 2007 to Dec 2010



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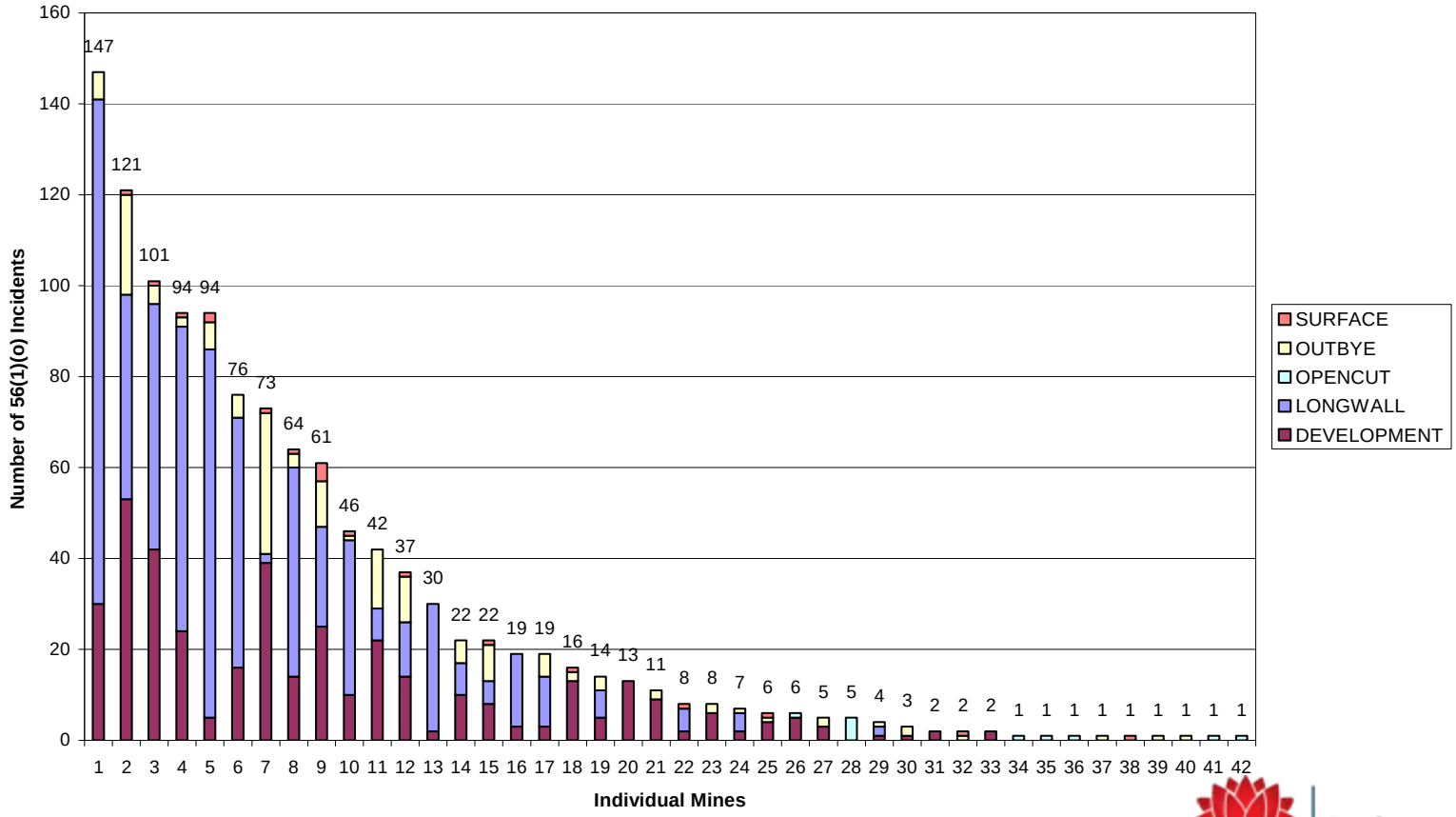
56(1)(o) Incidents by Mine and Location

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



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Longwall 56(1)(o) Incidents

- **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%**

Longwall 56(1)(o) Incidents cont

- **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%**

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Development Unit 56(1)(o) Incidents

- **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%**

Development Unit 56(1)(o) Incidents cont

- **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%**

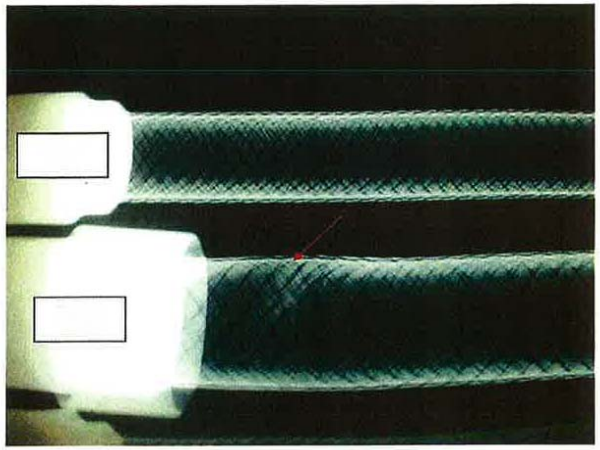
Development Unit 56(1)(o) Incidents cont

- **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

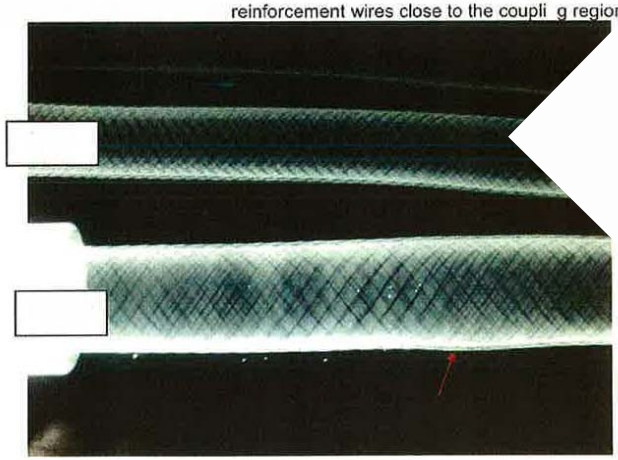
Development Units Drill Rigs (Roof) Failure Cause	No of Incidents	Percentage
Motor bonded hose pack	39	45.3%
Timber Jack hoses	5	5.8%
Other hoses identified	8	9.3%
Insufficient information	34	39.5%
Total	**86**	**100.0%**

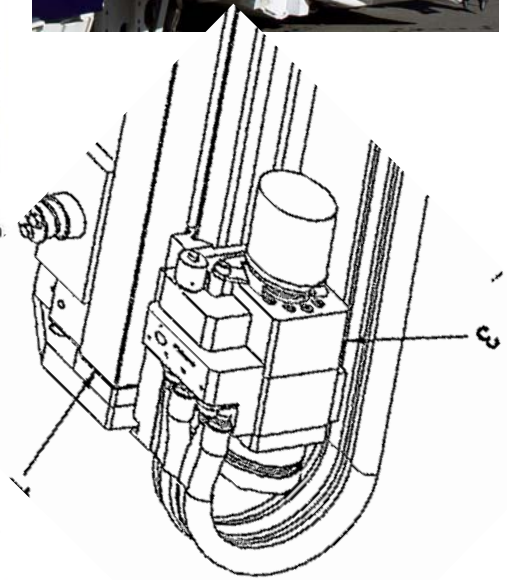
- **Figure 15**
  56(1)(o) Escape of Fluid Incidents in Development Units due to Hose Failure by Cause of Failure Jan 2007 to Dec 2010

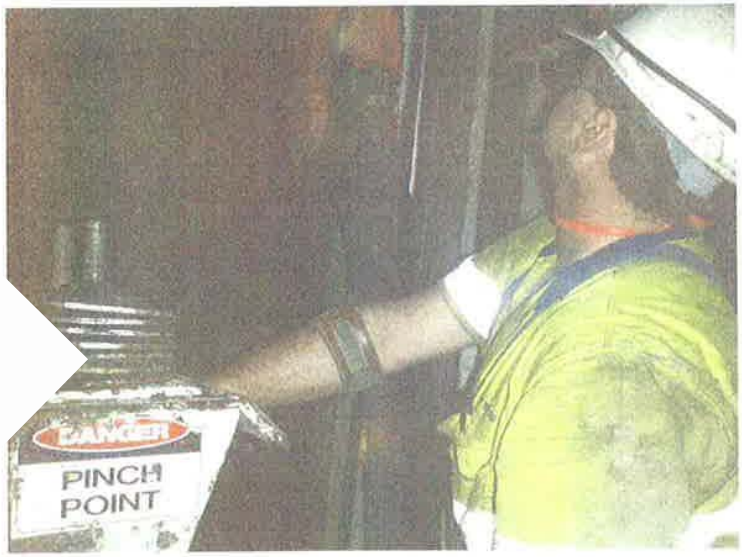
Development Units Rib Bolters Failure Cause	No of Incidents	Percentage
Motor bonded hoses	4	36.4%
Insufficient information	7	63.6%
Total	**11**	**100.0%**



reinforcement wires close to the coupli g region.







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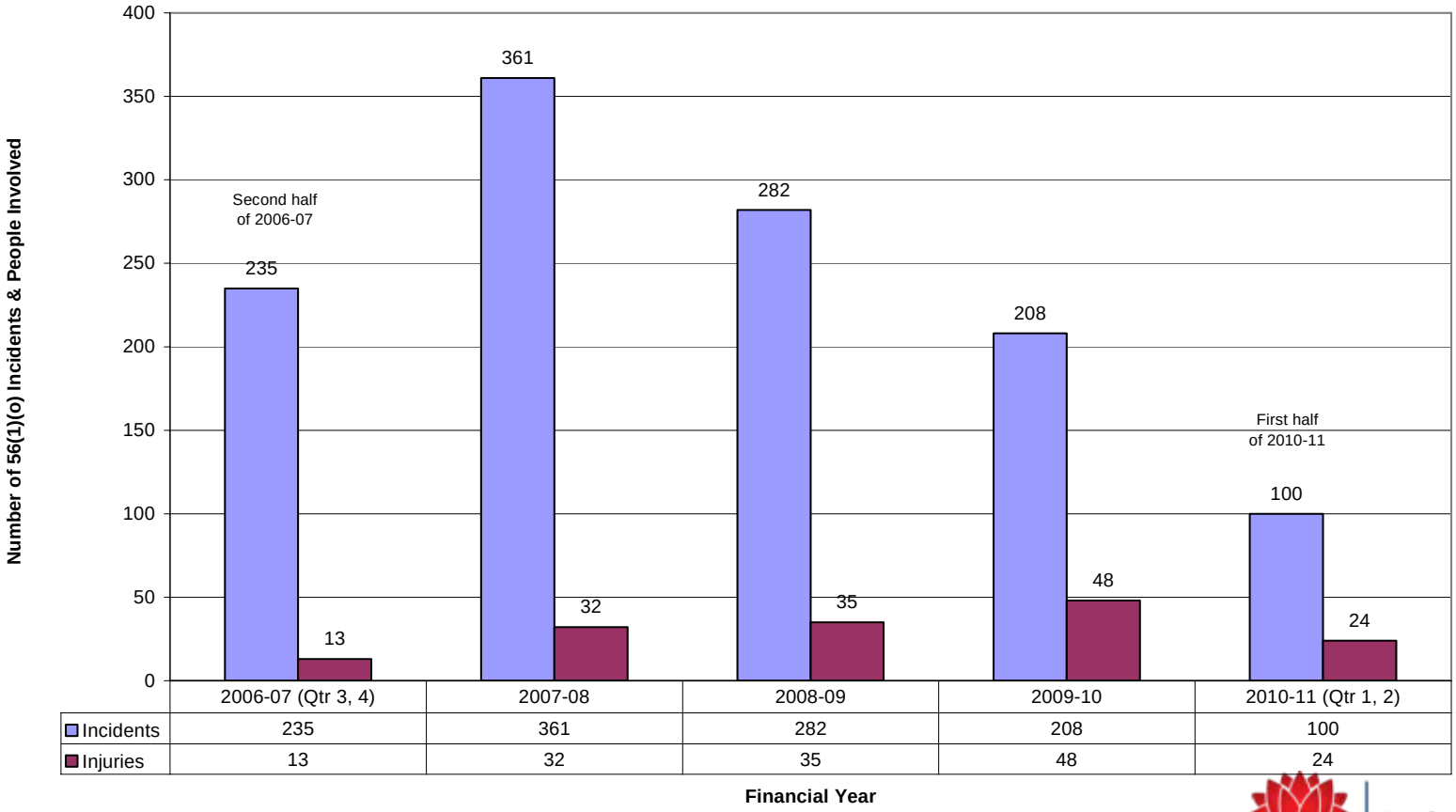
People Involved in 56(1)(o) Incidents

- For the 4 year period from January 2007 to December 2010:-
  - 152 people were involved in 1,186 incidents
  - **5 people received fluid injection injuries**
  - **1 person received a serious burn injury**
  - 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

People Involved in 56(1)(o) Incidents cont

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



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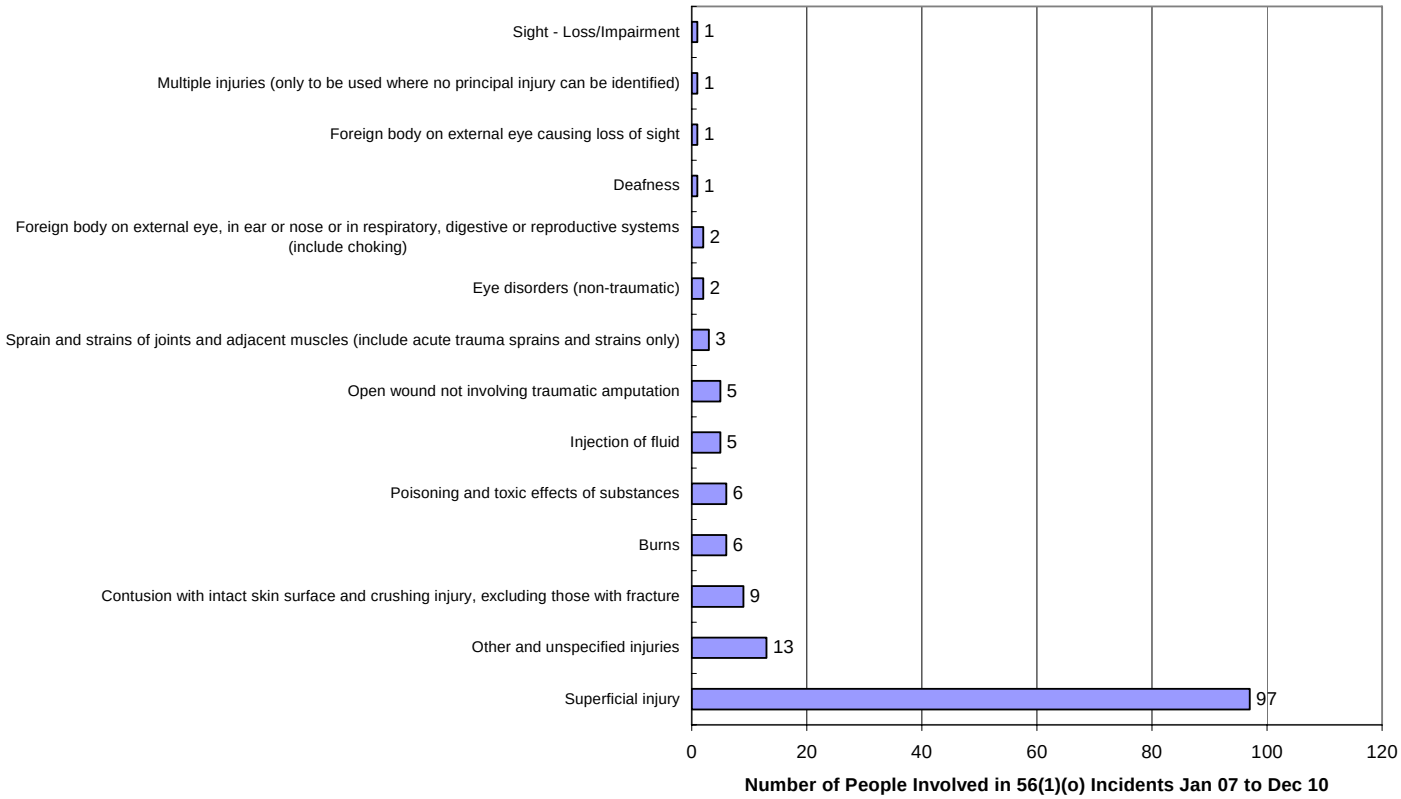
People Involved - Nature of Injury

- **Figure 18**
  People Involved in 56(1)(o) Escape of Fluid Incidents by Nature of Injury Jan 2007 to Dec 2010



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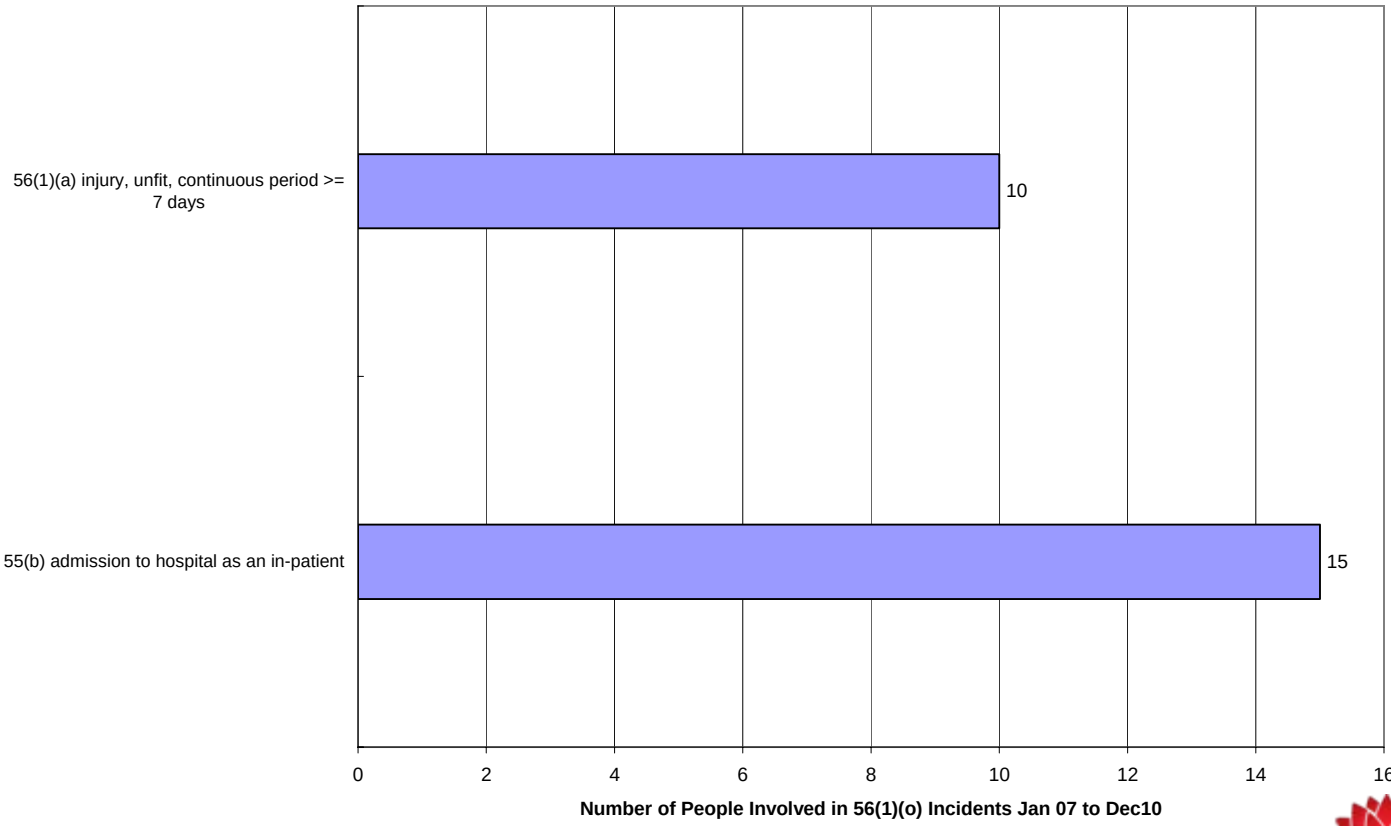
People Involved – 55(a)(v) Fluid Injection Injuries

1. Development unit:- 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).

People Involved - Notifiable Injury Outcomes

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



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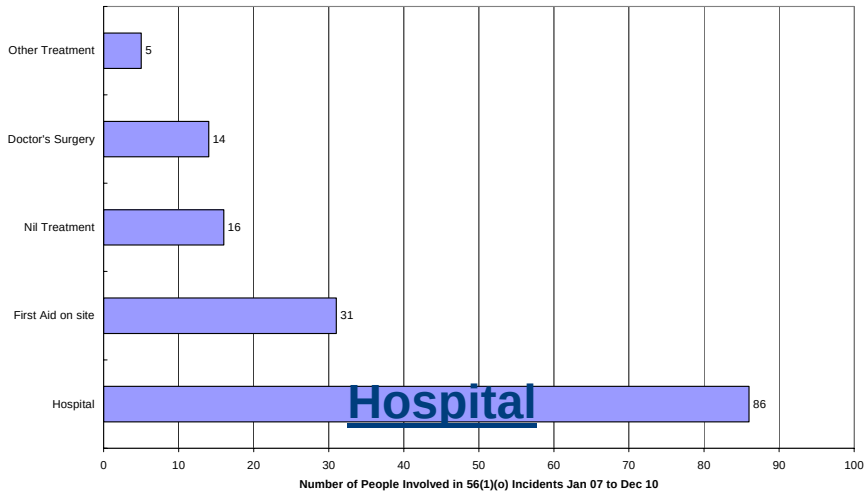
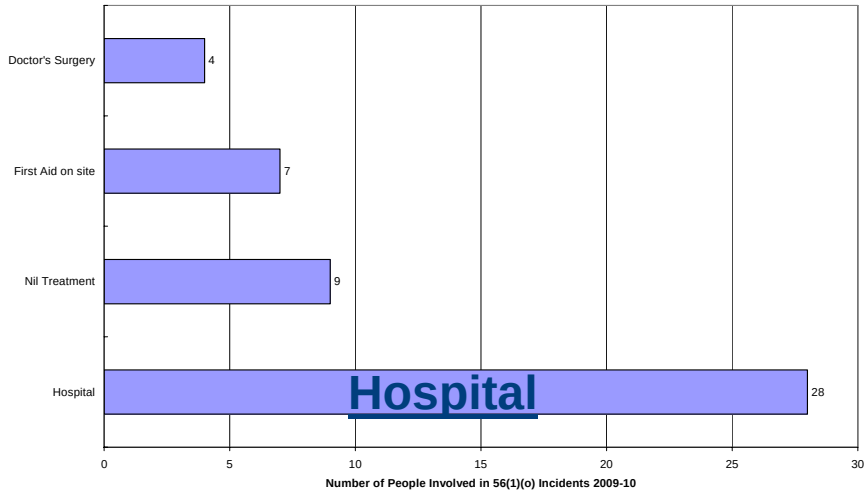
People Involved - Treatment

- **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



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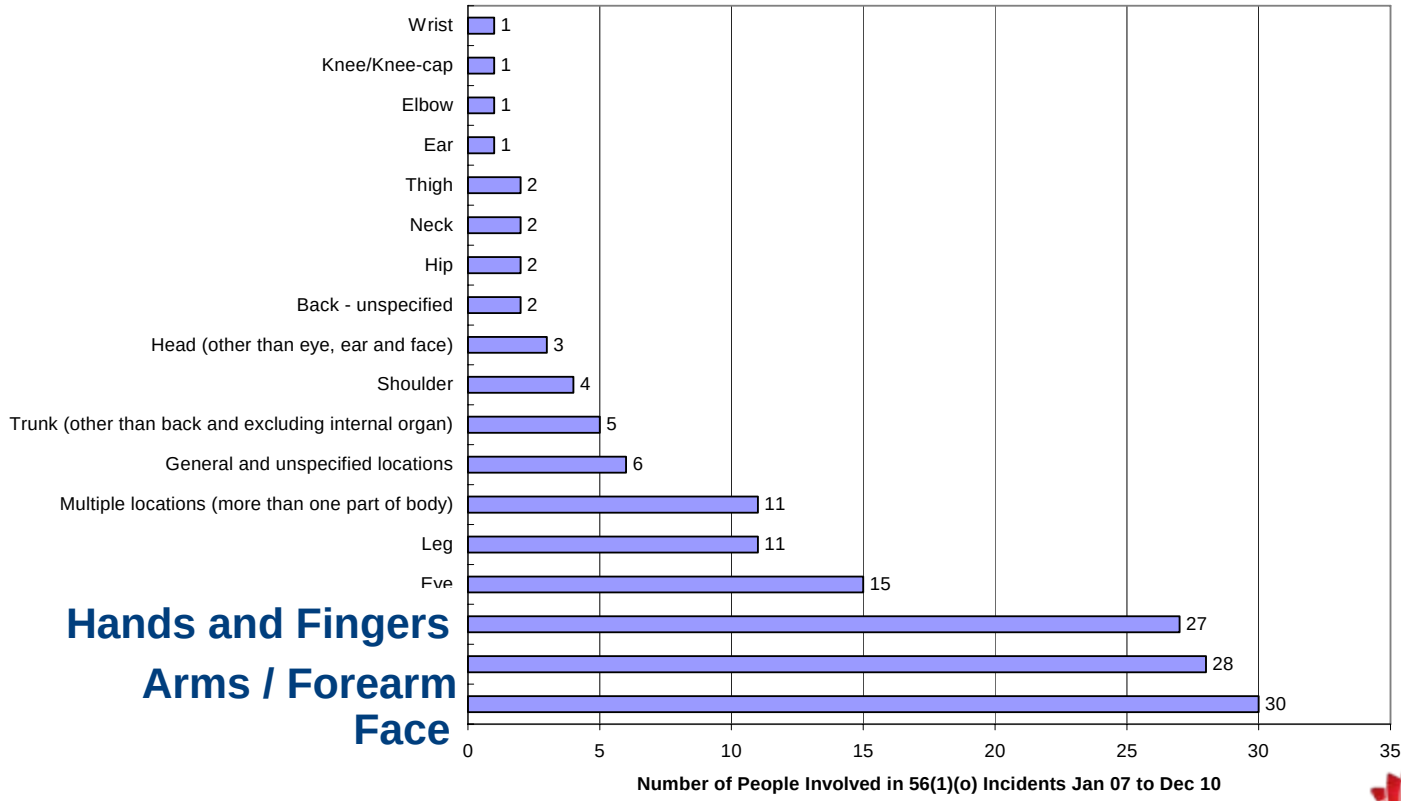
People Involved - Bodily Location

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



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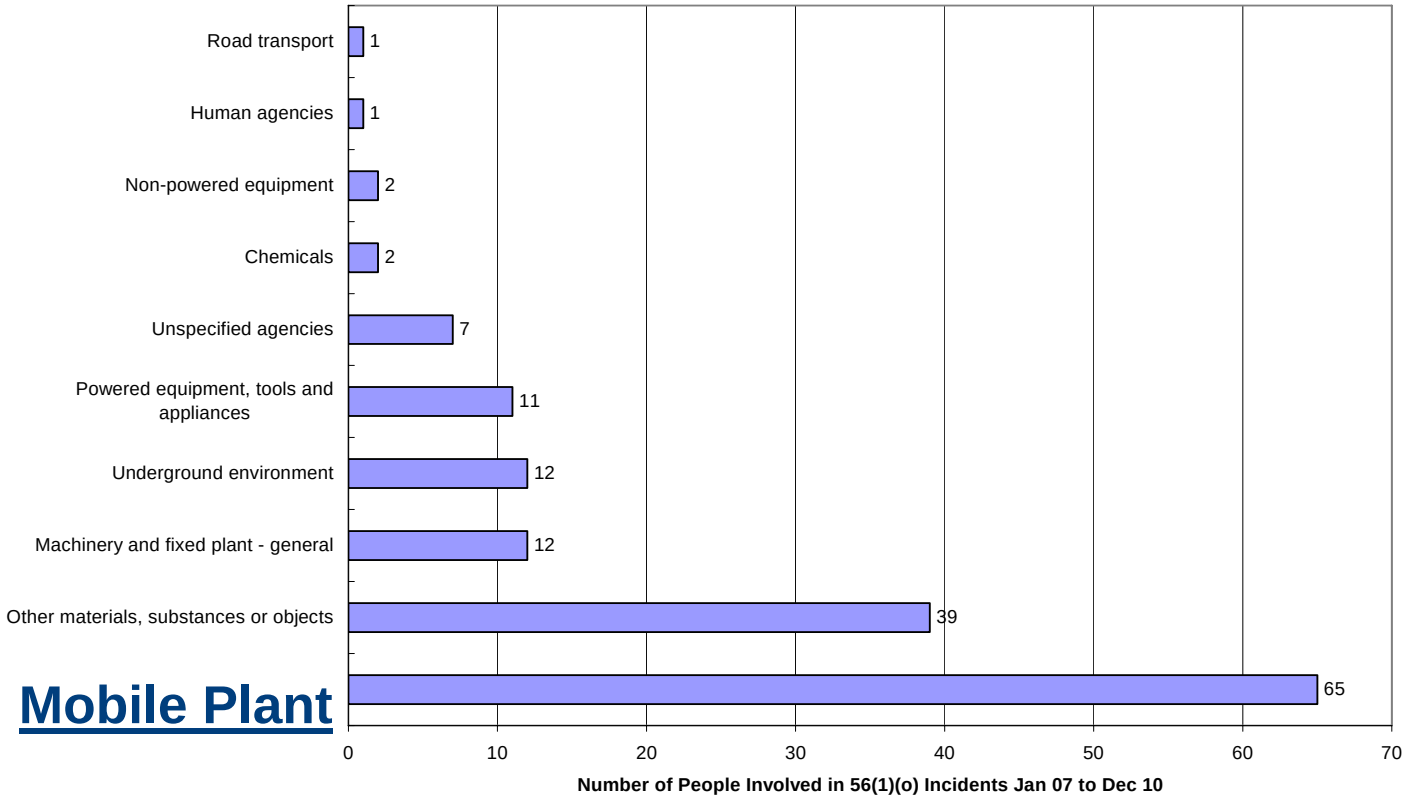
People Involved – Agency

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



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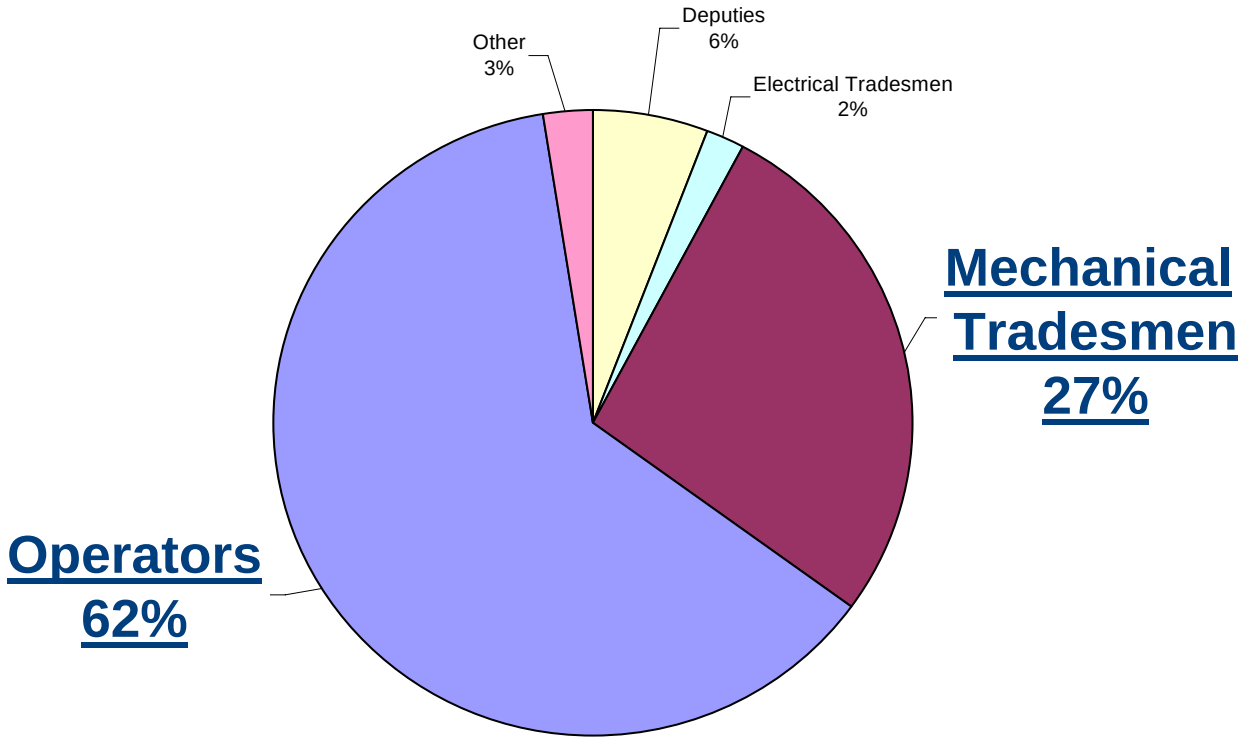
People Involved - Employment Category

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



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Additional Information

- **Figure 35**

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

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 information sourced from mines different mines different equipment
- 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

Summary

- High pressure is a major hazard
- This hazard needs to be managed
- Hydraulic equipment & systems are an asset
- Determine your planned maintenance strategy using life cycle
- Measure and monitor the operating and life performance of the equipment
- Change management to upgrade the maintenance to accommodate for the underground environment.