



## ACCIDENT AND INCIDENT PERFORMANCE IN THE DRILLING INDUSTRY

Since the advent of regulation of the exploration sector of the industry with the proclamation of the Mines Safety and Inspection Act 1994, the mines inspectorate has become increasingly concerned with the performance of some exploration and drilling companies, (and some producing mines where exploration activity is being undertaken), with regard to the protection of employees from well recognised and commonplace hazards in the exploration drilling workplace.

Some of the more enlightened exploration and drilling organisations have taken their own steps to ensure that their workplaces are as free from hazards as is practicable and for this they are to be highly commended. However, the remainder of the industry has some way to go in order to provide the necessary protection for its workforce from foreseeable and preventable injury.

The inspectorate holds concern principally in two areas:

- The maintenance of the necessary impetus for continuous improvement within those enlightened organisations which are already treating management of the hazards and risks associated with drilling in a proactive fashion; and
- The bringing up to the required standard of conduct of those operators or organisations which still appear to believe that the responsibility for the prevention of injury in the industry lies solely with the employees on the job.

The attention of employers in the industry (drilling and exploration companies and operating mines alike) is specifically drawn to the provisions contained in the Mines Safety and Inspection Act 1994 (MSIA) and the Mines Safety and Inspection Regulations 1995 (MSIR); in particular, attention is drawn to the following:

### Mines Safety & Inspection Act (MSI Act) – Section 4

*"employer"* means a person who employs an employee at a mine under a contract of employment or apprenticeship;

*"exploration operations"* means any exploration activity which is undertaken on a mining tenement, whether offshore or on land, but does not include -

- (a) any development work involving underground operations; or
- (b) the excavation of any trial pits beyond the extent permitted under the tenement conditions; or
- (c) remote sensing activity carried out using airborne or satellite mounted equipment (except for ground based activity in support of such remote sensing activity);

*"hazard"* in relation to a person, means anything that may result in injury to the person or harm to the health of the person;

*"mine"* means a place at which mining operations are carried on and, where mining operations are being carried on in conjunction with one another at 2 or more places, those places are to be taken to constitute one mine unless the State mining engineer notifies the principal employer in writing otherwise in accordance with subsection (3); and "to mine" includes to carry on any manner or method of mining operations;

*"mining operations"* means any method of working by which the earth or any rock structure, coal seam, stone, fluid, or mineral bearing substance is disturbed, removed, washed, sifted, crushed, leached, roasted, floated, distilled, evaporated, smelted, refined, sintered, pelletised, or dealt with for the purpose of obtaining any mineral or rock from it for commercial purposes or for subsequent use in industry, whether it has been previously disturbed or not, and includes -

- (a) exploration operations; and ...

*"practicable"* means reasonably practicable having regard, where the context permits, to -

- (a) the severity of any potential injury or harm to health that may be involved and the degree of risk of such injury or harm occurring; and
- (b) the state of knowledge about -

- (i) *the injury or harm to health referred to in paragraph (a); and*
  - (ii) *the risk of that injury or harm to health occurring; and*
  - (iii) *means of removing or mitigating the potential injury or harm to health;*
- and*
- (c) *the availability, suitability, and cost of the means referred to in paragraph (b) (iii);*

## **MSI Act s.9**

### ***Duties of employers***

9. (1) *An employer must, so far as is practicable, provide and maintain at a mine a working environment in which that employer's employees are not exposed to hazards and, in particular, but without limiting the generality of that general obligation, an employer must -*

- (a) *provide and maintain workplaces, plant, and systems of work of a kind that, so far as is practicable, the employer's employees are not exposed to hazards; and*
- (b) *provide such information, instructions and training to and supervision of employees as is necessary to enable them to perform their work in such a manner that they are not exposed to hazards; and*
- (c) *consult and co-operate with safety and health representatives, if any, and other employees at the mine where that employer's employees work, regarding occupational safety and health at the mine; and*
- (d) *where it is not practicable to avoid the presence of hazards at the mine, provide employees with, or otherwise provide for the employees to have, such adequate personal protective clothing and equipment as is practicable to protect them against those hazards, without any cost to the employees; and*
- (e) *make arrangements for ensuring, so far as is practicable, that -*
  - (i) *the use, cleaning, maintenance, transportation, and disposal of plant; and*
  - (ii) *the use, handling, processing, storage, transportation, and disposal of substances, at the mine is carried out in such a manner that that employer's employees are not exposed to hazards.*

(2) *In determining the training required to be provided in accordance with subsection (1) (b), regard must be had to the functions performed by employees and the capacities in which they are employed.*

(3) *For the purposes of this section, where, in the course of mining operations carried on by a person (in this section called "the principal"), the principal engages another person (in this section called "the contractor") to carry out work for the principal -*

- (a) *the principal is deemed, in relation to matters over which the principal has control or, but for an agreement between the principal and the contractor to the contrary, would have had control, to be the employer of -*
  - (i) *the contractor; and*
  - (ii) *any person employed or engaged by the contractor to carry out or to assist in carrying out the work; and*
- (b) *the persons mentioned in paragraph (a) (i) and (ii) are deemed, in relation to those matters, to be employees of the principal.*

(4) *Nothing in subsection (3) derogates from -*

- (a) *the duties of the principal to the contractor; or*
- (b) *the duties of the contractor to persons employed or engaged by the contractor.*

(5) *The duties imposed under subsection (1) on an employer who is the principal employer at a mine are not taken to be carried out only by the appointment of a manager for the mine.*

(6) *Notwithstanding subsection (1), any duty imposed under that subsection on an employer who is not the principal employer at the mine applies only in relation to matters over which the employer who is not the principal employer has control, or but for an agreement between the 2 employers, would have had control.*

## **MSI Act s.14**

### ***Duties of manufacturers etc.***

14. (1) *A person who designs, manufactures, imports or supplies any plant for use at a mine must, so far as is practicable*

- (a) *ensure that the design and construction of the plant is such that persons who properly install, maintain or use the plant are not, in doing so, exposed to hazards; and*

- (b) *test and examine, or arrange for the testing and examination of, the plant so as to ensure that its design and construction are as mentioned in paragraph (a); and*
- (c) *ensure that adequate information in respect of -*
  - (i) *any dangers associated with the plant; and*
  - (ii) *the specifications of the plant and the data obtained on the testing of the plant as mentioned in paragraph (b); and*
  - (iii) *the conditions necessary to ensure that persons properly using the plant are not, in doing so, exposed to hazards; and*
  - (iv) *the proper maintenance of the plant,*  
*is provided when the plant is supplied, and subsequently whenever requested.*

(2) *A person who erects or installs any plant for use at a mine must, so far as is practicable, ensure that it is so erected or installed that persons who properly use the plant are not subjected to any hazard that arises from, or is increased by, the way in which the plant is erected or installed.*

(3) *A person who designs or constructs any building or structure, including a temporary structure, for use at a mine must, so far as is practicable, ensure that the design and construction of the building or structure is such that -*

- (a) *persons who properly construct, maintain, repair or service the building or structure; and*
- (b) *persons who properly use the building or structure,*  
*are not, in doing so, exposed to hazards.*

(4) *A person who manufactures, imports, or supplies any substance for use at a mine must, so far as is practicable, ensure that adequate toxicological data in respect of the substance and such other data as is relevant to the safe use, handling, processing, storage, transportation, and disposal of the substance is provided when the substance is supplied, and subsequently whenever requested.*

## **MSI Regulations - Regulation 6.2**

### ***Plant to be maintained and operated in a safe manner***

6.2. (1) *The principal employer, and every other employer, at a mine must ensure that, in respect to any plant in the mine -*

- (a) *a system is implemented to identify any hazards associated with the plant, and assess the risks of an employee being exposed to those hazards; and*
- (b) *all practical measures are taken to reduce those risks,*  
*in order to ensure that the duties of employers under Part 2 of the Act to provide and maintain a safe working environment in relation to plant is carried out successfully and effectively.*

(2) *As a minimum, consideration should be given to the following methods of risk reduction -*

- (a) *ensuring that the plant is manufactured, inspected and, where required, tested according to the relevant Australian standards and having regard to the designer's specifications;*
- (b) *ensuring that if after supply to a mine, any plant is found to have a fault that may affect safety or health, as far as is practicable, the person to whom the plant was supplied is advised of the fault and what is required to rectify it;*
- (c) *ensuring that there is sufficient access and egress to the parts of the plant that require cleaning or maintenance, and to the operator's workstation for normal and emergency conditions;*
- (d) *providing emergency lighting, safety doors and alarm systems, if access to the plant is required as part of its normal operation and persons may become entrapped and at risk of being exposed to hazards due to heat, cold or lack of oxygen;*
- (e) *attempting to reduce, as far as is practicable, any risk of exposure to a hazard created by dangerous parts during operation, lubrication, adjustment or maintenance;*
- (f) *ensuring that any guarding provided for plant and its operation comprises -*
  - (i) *a permanently fixed physical barrier - where no person requires complete or partial access to the dangerous area during normal operation, maintenance or cleaning;*
  - (ii) *an interlocked physical barrier - where a person may require complete or partial access to the dangerous area during normal operation, maintenance or cleaning; or*
  - (iii) *a physical barrier securely fixed in position by means of fasteners or other suitable devices, sufficient to ensure that the guard cannot be altered or removed without the aid of a tool or key (but only where a guard in accordance with subparagraphs (i) or (ii) is not practicable), but, if none of the guards described in subparagraphs (i), (ii), or (iii) are practicable, by providing a presence sensing safeguard system;*
- (g) *ensuring that operational controls are -*
  - (i) *suitably identified on plant so as to indicate their nature and function;*
  - (ii) *located so as to be readily and conveniently operated by each person using the plant;*

- (iii) *located or guarded to prevent unintentional activation; and*
- (iv) *able to be locked into the “off” position to enable the disconnection of all motive power and forces;*
- (h) *ensuring that -*
  - (i) *if practicable, the plant does not need to be operating while maintenance and cleaning is taking place; or*
  - (ii) *operational controls which permit controlled operation of the plant are provided, if it is not practical to eliminate the need for plant to be operating while maintenance and cleaning is taking place;*
- (i) *ensuring that plant that is designed to be operated or attended by more than one person, and which has more than one control fitted, has multiple controls of the “stop and lock-off” type, so that the plant cannot be restarted after a stop control has been used unless each stop control has been reset; and*
- (j) *ensuring that emergency stop devices -*
  - (i) *are prominent, clearly and durably marked, and immediately accessible to each operator of the plant;*
  - (ii) *have handles, bars or push buttons that are coloured red; and*
  - (iii) *will not be affected by electrical or electronic circuit malfunction, as may be appropriate to the particular case.*

## IMMEDIATE CONCERNS

As may be readily discerned from the extracts above, the statute law of Western Australia includes exploration drilling operations as “mines” by definition and casts several general and specific duties on employers in such operations. In this context, the term “employer” also includes a “principal employer”, who may be the operating company of a producing mine, or an exploration company engaged in the search for minerals in an area remote from production operations. The law quite clearly casts the same duties on such principals as it casts on drilling contractors who may be the direct employers of the employees engaged in exploration operations.

The duty cast upon **all employers** is simple: they must **provide and maintain** (at least, so far as is practicable under the circumstances of the particular case) a **working environment in which the employees** of each individual employer **are not exposed to hazards**.

It is apparent from the deplorable record of incidents in the drilling industry that not all employers (or principal employers) associated with that industry are taking their statutory obligations with the seriousness warranted by the hazards, risks and possible (or probable) consequences.

The main factors causing most concern in the inspectorate resolve themselves into inappropriate action (or, in some instances, no action) being taken to obviate or mitigate the harm to employees which may be (and frequently is) caused by some common and well known hazards in the drilling industry and/or the equipment and practices used in that industry. These are:

- drilling work practices
- mechanical and maintenance work practices
- rod and drill-string handling
- employees being caught in rotating parts
- employees being caught between objects or parts  
and
- the effects of fluids (gases and liquids) under high pressure.

The examples given below represent some of the more serious drilling accidents and incidents reported to the inspectorate within a period of some eighteen months commencing in January 1996. The commonplace (at least insofar as the drilling industry is concerned) nature of most of the incidents cannot mask the seriousness of the potential or actual consequences of failing to deal with a recognised hazard.

## EXAMPLES OF INJURIES

### Drilling Work Practices

While drilling a hole, an airleg miner underground intersected a drill hole made by a surface diamond drill. The pressure and volume of water which emerged from the hole indicated that the surface drill hole had passed through an aquifer. A second drill hole, bored into the face to be used as an anchor, connected with the same water source and caused the flow to increase beyond the capabilities of the pumps at the face. Both holes were eventually stemmed and the water source was pressure grouted.

A drill hole being drilled from the surface to intersect the underground workings broke through before the area had been cleared of personnel and equipment. The driller had miscounted the number of drill rods on the string. Drilling mud entered the mine dewatering system, causing the sump to overflow and tripping out the mine power.

***While drilling at the plant site near the crusher a drill hit the main power cable (415 volts) to the crusher. The drill rig was isolated for 24 hours due to the danger of tyre explosion.***

A reverse circulation drill hole intercepted the decline, causing a minor rock fall and just missing service facilities. The collar of the hole had been drilled 19 metres from the designated position.

***Two diamond drillers drilled a hole from the decline into the ventilation decline above. The drill bit emerged in the ventilation decline wall 2 metres behind a face that was being charged with explosives.***

### **Mechanical/Maintenance Work Practices**

A drilling assistant required surgery to remove a sliver of steel from his abdomen following a mishap while changing drill bits. Drilling had stopped and the last drill rod had to be removed by applying two stillsons and hitting the stabiliser with a steel hammer to break the joint. The stabiliser had a build up of hard-faced weld, a piece of which sheared off at impact and struck the worker. Initial medical treatment was administered on site and he was then evacuated to hospital.

A driller's offsider had a piece of metal fly off a drillrod and lodge in his chest when he hit the drill sub with a hammer to free it from the drill string.

### **Rod and Drill-String Handling**

***A driller's offsider sustained a fractured forearm while guiding a drill rod into the PVC collar. His elbow was propped on a metal ledge, and his hand was pushing sideways on the drill string when the hammer came down.***

***A relief driller received a fractured vertebra when he was struck by a drill rod. He was engaged in pulling and unscrewing drill rods from a horizontal drill hole when the rod pivoted on the stillson wrench that was holding it, and swung hitting the driller.***

A driller's offsider received injuries to his shoulder and back when he fell from the elevated catwalk of a drill rig. He had been pushing drill rods into the rack when a rod caught on a cross support and bounced back, knocking him from the platform.

A driller's offsider was rendered unconscious when struck on the chin by a drill rod. The offsider was running the rod onto the rack when it became caught between the drill head and the mast.

A driller's offsider received bruising to the chest when he was struck by a drill rod and knocked from the platform on which he was standing. The rod was being removed from the drill hole when it pivoted on the Stillson wrench holding it and swung around hitting the man.

A diamond driller suffered a back injury when he was struck in the chest by a drill rod. The impact knocked him off the drill platform and he struck his back on a tool chest in the adjacent driller's hut.

A driller's offsider sustained head injuries when he was struck on the helmet by a drill rod which fell during breaking of the rod string.

***A trainee driller had the top of his finger severed when it became caught while attempting to attach a drill rod.***

***A driller's offsider sustained a fractured arm when he was caught between the drill rods he was attempting to place in the rack.***

A driller's offsider collided with the slips table and injured his knee when he fell while running a drill rod.

A driller received facial injuries and was knocked unconscious when he was struck on the head by a drill rod when the clam shell broke while the rod was being swung into position.

***A driller received lacerations and a broken cheekbone when he was struck by the jaw of a stillson wrench which broke during the removal of drill rods.***

A driller sustained cuts to his head when he was struck by a drill rod which broke free at the saver sub while it was disconnected at the bottom.

A driller's offsider received bruising and a pinched nerve in his back when he slipped while trying to load drill rods into the rod basket. The boots he was wearing were muddy and slipped on the smooth surface of the steel plate on which he was standing.

A driller's offsider twisted his knee when he tripped while carrying a drill rod.

A driller's offsider suffered concussion when he was struck by a drill rod. The rod was being winched from the back of a truck into the rod bin of the rig when the end of the rod snagged on the rig. The other end of the rod swung and hit the worker on the side of the head.

A driller's offsider received lacerations and bruising to the head when removing a drill rod. The rod was unthreaded too far causing it to pop out and strike the worker.

***A driller's offsider suffered a fractured wrist when manhandling a 70kg drill hammer. The victim lost his footing on the platform and the hammer fell and crushed his wrist against the slips.***

A driller's offsider suffered ligament damage to his knee when he stepped on to a platform on the side of the rig while running drill rods and twisted his knee.

A driller's offsider suffered damaged ribs when he fell against the handle of the rod spanner. While putting a new rod on the drill the victim's leg slipped through the rod aperture in the platform, causing him to fall forward.

A driller's offsider suffered a laceration to his leg when he missed his footing while stepping on to the drill platform, and caught his leg on the edge of the platform.

***A driller's offsider suffered a broken arm when he slipped in the mud while carrying a drill rod. The rod fell on his arm.***

A driller's offsider suffered a strained lower back and possible soft tissue damage when he misjudged his step when getting on to a slips platform while carrying a drill rod.

A driller's offsider suffered severe bruising to his calf muscle when he raised the 6 metre rod to check the bit. A stillson was used to hold the rod connection and was resting on the ground. The stillson slipped and swung around, hitting the victim on the leg.

An exploration driller suffered a lacerated finger when attaching a clam shell to the line. His finger was jammed between the rod and the clam shell.

***A driller's offsider received a broken finger when his hand was squashed beneath a metal weight.***

An exploration driller crushed and lacerated his hand when it was caught between the bit stop and a down hole camera he was trying to prevent from falling back down the hole after the overshot dogs released.

***A driller's offsider broke his forearm while lifting rods. He could not remember any particular incident that may have caused the injury, a previous break to the arm had occurred some years ago.***

***A driller's offsider was struck on the cheek by an overshot that was being lifted off a bench. He received a fractured jaw and cheekbone.***

### **Caught in Rotating Parts**

A driller had his finger crushed when it became caught between the drive chain and a cog on a drill rig while he was being hoisted up the drill mast to reposition a winch cable.

***A driller died from severe head and multiple body injuries when he became entangled between the rotating drill rod and the drill mast.***

A driller received crush injuries to two fingers when they became caught by the return sprocket of his machine. The drill jammed in loose ground during drilling, and the driller had put his hand on the pull down chain while attempting to free the drill.

***A driller's offsider suffered a broken and lacerated finger when his hand became caught between the chain and the frame of the rig while adding rods to the string.***

A driller's offsider received a lacerated ear and bruising to the head when removing rods from the hole. A large stillson wrench was being used to unscrew the rods, and when the two rods separated the stillson swung round and struck the victim on the head.

***A driller's offsider suffered a small broken bone in his hand when unlocking a drill rod. The stillson wrench slipped and he caught his hand between the stillson and the other spanner.***

***A driller had his arm torn off when his clothing became caught in a rotating drill rod. The driller was attempting to put on a new starter rod while the mast was up and the rods were out of the ground.***

***A driller received broken bones in his hand when it became trapped between the drill rod column and a stillson wrench.***

***A diamond driller suffered injuries to his shoulder, neck, chest and spine when his clothes became caught by the spinning drill rod and he was dragged into the mast cavity. His assistant activated the emergency stop button and cut the victim free.***

### **Caught In or Between Non-Rotating Parts**

***A driller received a fractured wrist when his arm was caught in the cyclone unit of the drill rig.***

A driller received a bruised foot when it was crushed by the drill string while he was attempting to adjust the slip rings.

A field assistant received a crushed finger when it was caught between the splitter and riffle box of a RC drill rig. She grasped the splitter to help herself stand up when a drillers offsider shook the splitter causing her finger to become jammed.

A driller's offsider received bruising and lacerations to his fingers while breaking rods with a stillson wrench. The rod dropped a short distance, jamming his fingers between the stillson handle and the footplate.

***A driller's offsider had his middle and half his ring finger severed when they became trapped between the core barrel and the frame of a diamond drill rig. The driller and the offsider were aligning the core barrel when a hydraulic ram was activated trapping the offsider's hand.***

***A driller suffered a broken foot and toe when his foot was crushed between the mast and the travel block. The victim was on the mast inspecting a jammed rod, with one foot on the mast and the other on the safety ladder. He instructed the offsider to move the drill head, and the travel block caught his foot.***

A driller's offsider at an exploration site badly lacerated his thumb while attempting to clear a blockage from the bottom of the cyclone. He accidentally knocked the air lever which caused the trap door to close on his thumb, which was later amputated.

A contract driller suffered crush injuries and lacerations to a little finger when his hand was caught between a pull-down rope and its sheave while locating a hammer on the bottom of the hole.

### **Effects of High-Pressure Fluids**

***A driller's offsider received injuries to his back and a broken shoulder when he was struck by the flailing return water hose of a drill rig. Two offsidars had been instructed by the driller to stand on the return hose while he blew back to clear water from the drill hole. The large volume of water coming out caused the hose to lash about, throwing both offsidars to the ground and resulting in the injured person being struck by the metal clamp at the end of the hose.***

A driller's offsider narrowly missed being struck as the concrete plug of a disused drill hole blew out of the ground when a new drill hole was pressurised nearby. The disused hole was covered and not visible to the drillers prior to drilling commencing.

Foam was applied to stabilise a hole being drilled through detritals. On pulling the rods back to the surface air pressure blew mud and rock out of the hole.

During drilling a sample hose on the rig was punctured half way along its length resulting in the sample being propelled out, narrowly missing the driller's offsider.

***An exploration driller suffered a broken arm and injuries to the upper body and head when he was struck by a sample bull hose. The hose had broken loose from the connection at the head of the drill and the safety sling had also broken.***

A grade control driller's offsider jarred his back when ground around the collar of a blocked drill hole lifted suddenly after the hole became pressurised.

***A driller's offsider attempted to remove a blockage in the drill pipe using the blow down sub. On removing the sub air at 350 psi was released resulting in severe abrasions to his right hand. It appears that the air regulator failed and allowed air at 350 psi to pass through the head.***

## **SUMMARY**

All employers in the drilling industry: mine operators, exploration companies and drilling contractors alike, are strongly advised to take seriously the need to eliminate accidents and injuries resulting from these well recognised hazards. A failure to do so will have the most serious consequences, both for employees in the industry who will be injured as a result of those hazards, and for employers who may be called to account in the criminal courts for failure to comply with the standards of conduct required by the law of the State.

In previous studies of fatal accident causation the issues of hazards in rod-handling and working in proximity to rotating parts were given emphasis, and it was pointed out that engineering solutions were practicable.

Some drilling companies and manufacturers have taken these precautions. Many have not.

The Inspectorate will be working to have the industry agree that after a specified period for remedial action to be effected, no drilling equipment will be accepted on minesites which does not have these hazards adequately removed by engineering design and manufacture.

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