DRILLING HAZARDS

REPORT

DEPARTMENT OF MINERALS AND ENERGY WESTERN AUSTRALIA

MOSHAB
Mines Occupational Safety and Health Advisory Board

FOREWORD

The Mines Occupational Safety and Health Advisory Board prepared this Drilling Hazards Report following findings and recommendations by its Drilling Hazards Sub-Committee. The Sub-Committee was established as part of the Board's inquiry into mining fatalities in September 1997.

Due to wide range of issues and recommendations raised by the Sub-Committee, some outside of its stated terms of reference, the Board resolved to not endorse or publish the Sub-Committee reports alone. Instead the Board commissioned the State Mining Engineer to prepare an Executive Summary and Action Plan of the Sub-Committee reports.

Following receipt of the State Mining Engineer's report, and taking into consideration both the seriousness of some of the findings of the Sub-Committee and the incidence and severity of the occupational injuries in the WA mining exploration sector, the Board agreed to combine all three reports into one publication for release.

The State Mining Engineer's report forms Part A of this report, while the Drilling Hazards Sub-Committee reports form Part B and Part C. The more than 500 recommendations made by the Sub-Committee have not been included in this Report but are available in a separate publication which can be accessed through the Department of Minerals and Energy's website (www.dme.wa.gov.au).

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DRILLING HAZARDS REPORT

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EXECUTIVE SUMMARY AND ACTION PLAN

OF THE REVIEW OF THE REPORT

PRELIMINARY

A component of the Inquiry into Fatalities in the Western Australian Mining Industry was a report on Drilling Hazards by a Sub-committee established by Mines Occupational Safety and Health Advisory Board (MOSHAB).

The terms of reference for that task (**Appendix D in the Inquiry Report**) are attached.

The Sub-committee carried out the task during 1998 and provided its report to MOSHAB in two volumes, **Part 1** in November 1998 and **Part 2** in January 1999.

MOSHAB considered the report and requested that a condensation in the form of an Executive Summary and Action Plan be developed by the State Mining Engineer (SME).

This task has been carried out with a work group comprising the SME, David Stevens, Sub-committee member and then President of the WA Branch of the Australian Drilling Industry Association (ADIA), and John McGee, Mechanical Engineer (DME), who chaired the Sub-committee.

The Report is very detailed (particularly **Part 2**) and will remain as a reference document on the issues considered.

A number of the matters raised have been dealt with in whole or in part by operators in the industry in the course of 1998 and 1999, and a strong impetus for change and improvement in equipment and operating practices impacting on safety was generated by **Safety Bulletin No. 31** (Accident and Incident Performance in the Drilling Industry), issued by DME in September 1997.

This impetus is acknowledged in **Part 2** of the Report, to which **Bulletin 31** is appended.

Reference is made in this Summary, and where appropriate in the Action Plan, to issues which has been the subject of ongoing action during 1998 and 1999.

EXECUTIVE SUMMARY

PART 1 DRILLING HAZARDS SUB-COMMITTEE REPORT

Report on Managing Risks Associated with Drilling Rigs in use
in the Western Australian Mining Industry

ADDITIONS TO THE MOSHAB TERMS OF REFERENCE

- Prevention of fires – fire fighting
- Shutdown facilities
- Training

COMMENT ON RECOMMENDATIONS (See Page 29 – 30 of this Report)

1. Develop an Australian Standard equivalent to European Standard EN791 -Drill Rigs Safety.

While recognising that MOSHAB can not unilaterally direct or require the development of an Australian Standard, the merits and drawbacks of the proposal were considered by the work group. It was recognised that development of a Standard is a protracted process, and it was pointed out that in general, operating standards would not be incorporated into regulations.

A preferable approach is to seek to develop a high quality guideline document, which can reference other documents and Standards such as the European Standard.

The existing **Guidelines for Safe Operations for the Drilling Industry in Western Australia**, developed by the ADIA WA Branch under the guidance of Mr Stevens, would provide a very effective base on which to develop a more comprehensive document on safe operating practice. Material can also be drawn from the detail contained in the Drilling Hazards Sub-Committee Report, Volumes I and II.

However, substantial resources will be required to enable this to be completed in an acceptable time frame; (say 12 months from agreement on scope, format and resourcing). MOSHAB will need to consider what resources can be committed, if the development of a guideline is endorsed.

The existing ADIA document deals with:

- Rod Handling;
- Moving (rotating) Parts;
- Noise Attenuation;
- Dust Attenuation (including sampling and personal protective equipment); and
- General Safety Requirements;

The development of a guideline will provide an effective resource for the wide range of operators in the industry, in risk management.

Whether the industry wishes to support the future development of an Australian Standard on drilling is a matter for further consideration, but beyond the scope of this process.

2. Formal Research

Formal research was recommended on four subjects.

Thread forms for all drill pipes and rods, discard criteria for pipes and rods and material specifications.

- Whipchecks (hose restraints), and hose end attachments.

- Booster discharge hoses.
- Specification for air pressure regulators for sample hoses, and internal wear.

Each of these is considered below.

2.1 Thread form research

The intent of this recommendation is to arrive at an appropriate standardised thread form to ensure interchangeability and eliminate the risks of jamming and thread failure.

Thread form development is a matter for action by the industry. It was brought out in discussion that the drill pipe manufactured in Kalgoorlie for Reverse Circulation (RC) Drilling is a modification of a standard American Petroleum Institute (API) thread to accommodate a larger inner tube.

These issues are matters for the supplier and manufacturer.

Discard criteria (thread form and pipewall, in relation to high air pressures) can be dealt with in the guideline. Establishment of these criteria, and effective application by operators, will reduce the risks of failure in service.

ACTION 1
The ADIA to determine appropriate thread forms and ensure that the adequacy of the design is verified by manufacturing and suppliers. Discard criteria to be established by the same process.

2.2 Whip checks

Deficiencies in whip checks and other hose restraints have been identified by industry practitioners. The risks attached to the hazard of hoses disconnecting under pressure are greatly increased with higher stored energy levels inherent in very high air pressures currently in the industry.

Whipchecks and other forms of hose restraints are again matters for resolution between the drilling operators and the manufacturers and suppliers. The latter group have a responsibility under the duty of care to supply fit for purpose equipment, provided that the criteria for use are properly specified.

The specification of end joints and constraint attachments should reference performance requirements, air-pressure, any abrasive effects etc.

The correct use and application of these should be covered in the proposed guideline.

Maximum use should be made of hard piping to keep flexibles to a minimum.

ACTION 2
Whip check standards to be determined by manufacturers and suppliers to operating criteria specified by the ADIA.

2.3 Booster discharge hoses

The issues here included specification and design criteria, to include operating conditions, ambient and internal temperature, operating pressure, pulse effects and end attachments.

The present practice is to use hoses developed for hydraulic operation in high-pressure compressed air applications.

Consideration needs to be given by the industry to hose standards and specifications appropriate to the task.

Internal wear on sample hoses is covered in 2.4 below

ACTION 3
ADIA to liaise with manufacturers to specify operating requirements including appropriate limits on service duties.

2.4 Air pressure regulators for sample hoses, internal wear checks

The concept promoted here was a safely vented "burst disc" type pressure regulator to avoid uncontrolled hose failure.

Internal wear is a problem as the hoses in general use are standard production hoses, which are not developed for usage resulting in internal abrasive wear.

No ready means of determining loss of hose integrity is available.

The only practicable remedy at present is regular change out and checking.

Follow up action on this group of recommendations is essential. It is the role and task of the user groups to do so, particularly by involving the manufacturers and suppliers in a full understanding of the application.

ACTION 4
These critical issues can be included in a technical bulletin to the industry, to be developed by the Chamber of Minerals (CME) and Energy and ADIA. The contents of this bulletin should be included in the proposed guideline.

3. Reporting of accidents and incidents.

The issue was raised in the context of some operators not reporting to principals, and some principals failing to report fully to DME.

This is a procedural issue, which is an obligation under the legislation. The Department issues reminders from time to time, but field monitoring by DME is not possible, due to the transience and mobility of operators. The final responsibility rests with the principals who engage drilling contractors, and who must exercise a credible level of supervision and monitoring of drilling activity.

OTHER ISSUES

Several other issues were discussed in varying degrees of detail in **Part 1**.

These included:

- Safety Culture
- The Mining and Quarrying Occupational Health and Safety Committee – MAQOHSC as a potential source of funding)
- Training and Experience
- Impact of Elevated Fluid and Air Pressures on Safety (factors were listed but no upper limits on pressures were proposed)
- Production Pressure and Remuneration
- Shift Work and Shift Cycles

The Conclusion contained observations on the role of:

- The Australian Drilling Industry Association
- Principal Employers
- The Department of Minerals and Energy

TIME FRAME FOR IMPLEMENTATION OF PART 1 RECOMMENDATIONS

The report proposed implementation of the recommendations after agreement by MOSHAB.

It was evident from the above discussion that these are essentially industrial development and manufacturing issues, which MOSHAB is not in a position to resolve, as implementation requires industry action.

MOSHAB may consider having the Standing Committee set up an industry work party to involve manufacturers and suppliers, and drilling industry operators, in framing risk management requirements for specific high risk applications. The feasibility of identifying and involving manufacturers in this specific manner will need to be explored as a first step in this process.

PART 2 DRILLING HAZARDS SUB-COMMITTEE REPORT

Managing Risks Associated with Drilling Rigs in Use
in the Western Australian Mining Industry

This Part comprises an Introduction, an Executive Summary and a detailed tabulation of hazards and recommendations dealing with the associated risks; this includes 73 items, each with multiple recommendations for action by manufacturers, drilling operators, principals.

MATTERS OUTSIDE THE TERMS OF REFERENCE

- Concerns over acceptance by principals of the lowest tender, irrespective of capacity for safe performance.

- Concerns on the lack of training of geologists who are appointed to direct drilling operations.

ISSUES RAISED IN THE EXECUTIVE SUMMARY OF PART 2

1. Rod Handling

The point was made here that automated rod handling is not a universal remedy to prevent injury. There is a range of operating factors to be dealt with. Improved mechanised (not automated) rod handling has been implemented generally in the past two years.

2. Roles and Responsibilities in Safety Management

Issues covered are itemised as dot points below.

Drilling Operators (Contractors)

- Shift rosters and shift lengths – journey planning
- Remuneration (production pressures, skills)
- Training needs
- Equipment selection/purchasing

Principals

- Need for senior corporate personnel to be aware of legislated OSH responsibilities, including management and supervision obligations and training, particularly for Geologists controlling drilling programs (training of Geologists)
- Tendering to include capacity for safe performance: (not simply the lowest bid)
- Involve contractors in planning the drilling program
- Report accidents and incidents (safety culture)

Manufacturers

- Manufacture to standards (a **minimum** standard is to comply with relevant regulations).

Department Of Minerals and Energy

- Consistency in administration of the legislation. The ADIA seeks involvement in development of regulations.

HAZARDS AND RECOMMENDATIONS

The tabulation contains 73 recommendations grouped under the 9 headings listed below; (sub-components of the primary recommendations number several hundred).

- Collection Systems for Drill Cuttings and Exhaust Discharge Systems
- Dust Attenuation
- Prevention of Fires and Fire Fighting*****
- Noise Attenuation
- Training Requirements (includes shift rosters and schedules and emergency preparedness) *****
- Emergency Shut Down Facilities*****
- High Operating Pressures
- Rod Handling Systems
- Protection from Rotating Parts

***** Additions to the Terms of Reference noted in the Summary of **Part 1**.

In each of the above groupings, MSI Act Regulations are referenced, where relevant, together with Australian and Overseas standards, as well as other relevant reports, codes of practice, procedures, manuals and safety publications.

The sub-components of the recommendations are listed for action by three groups:

- Manufacturers (and suppliers)
- Contractors (drilling operators)
- Companies (principals for whom the drilling is carried out)

Three categories of priority are listed and a rating attached to each sub-component:

P1 - immediate

P2 - short to medium term (research, design, modification needed)

P3 - desirable in the longer term

COMMENT

A study of the details contained in the tabulation shows that the great majority are matters, which are already required as general or specific obligations under the legislation, or dictated by prudent operating practice in relation to both efficiency and safety.

From this perspective alone, the tabulation is a valuable checklist for operating practices and procedures, and for equipment specification and maintenance checking. It will provide the basis for development of a comprehensive guideline.

However, the implementation of these functions and processes is essentially the responsibility of operators in the industry, with an appropriate level of monitoring and safety assurance auditing on the part of the principals who engage the services of drilling operators.

Issues which may warrant overview by or recommendation/direction from MOSHAB are outlined briefly below.

Occupational Hygiene

The revised Atmospheric Containment Sampling (CONTAM) system requires sampling to be carried out for drillers on exploration sites as well as personnel on or adjacent to operating minesites.

The DME conducted a briefing on CONTAM and its requirements for representatives from ADIA and exploration companies; (principals). Under the legislation the principal is responsible to ensure that these obligations are carried out.

Prevention of Fires and Fire Fighting

Fire prevention can be incorporated into the proposed guideline.

Noise Control

The prevention of hearing damage to employees is a major consideration for drilling operators.

Enterprises which lack the capacity to deal with CONTAM requirements and noise attenuation and hearing protection will need to utilise the services of consultants in these fields.

Training

Training and the development of adequate standards of competence are fundamental requirements for safe performance.

Reference is made to training needs and currently available capacity in **Part 1**.

Competency standards developed by the ADITC are currently subject to review and this process will include substantial input from the ADIA in Western Australia.

Australian National Training Authority (ANTA) support and funding will be sought for the program.

A program is being developed by Drillmark Consultants and Associates for the Central Metropolitan College of TAFE titled "**Drill Management for the Geologist**". Material in the Drilling Hazards Sub-committee Report will be drawn upon for this program.

ACTION PLAN

1. Development of a Comprehensive Guideline for Safe Performance in Drilling Operations

It is recommended that MOSHAB endorse the development of a Guideline for the drilling industry to assist principals and drilling operators in achieving continuous improvement, and high standards of performance in occupational safety and health.

The major role in developing this Guideline should be taken by the Chamber of Minerals and Energy, with the support of the ADIA and DME.

The Drilling Hazards Sub-committee Report, together with ADIA resource materials, will provide the basis for the Guideline. A range of appropriate resource material from other sources should be referenced.

Completion Target – *June 2001*

2. Occupational Health Promotion

The Chamber of Minerals and Energy Exploration Council, in conjunction with ADIA, co-ordinate a program of occupational health promotion on exploration sites where drilling is involved.

The program should be congruent with other exploration activities, and focus on:

- ergonomics (prevention of musculo-skeletal disease and injury)
- noise attenuation and hearing protection
- hazardous substances management
- atmospheric contaminant control and health protection
- heat stress, fatigue management and solar radiation protection.

The expertise of industry professionals can be drawn upon through the Chamber of Minerals and Energy's peak occupational safety and health committee.

Assistance and advice can be provided by the DME.

Completion Target – *ongoing - progress report December 2001*

3. Competency Based Training

When the Drilling Industry Competency Standards are approved by ANTA, an implementation program of competency assessment/development for the drilling industry is warranted.

It is recognised that achievement of this over even a reasonably extended time frame will be a major challenge for the industry, given the geographical spread, transient and short-term nature of activity and small establishment at each site which characterises the industry.

This is again an issue, which will require a co-ordinated effort between the Chamber of Minerals and Energy, the Association of Mining and Exploration Companies (AMEC), and the ADIA.

A partnership arrangement between drilling operators and appropriate Registered Training Organisations (RTOs), (such as TAFEs) may be the most effective approach to deal with assessment, but support from the principal through the Chamber's Exploration Council will be needed. Federal funding sources should be explored.

The same priority should be given to this program as that for the development of competency based underground miner training programs.

The Exploration Council should consider implementation of the "Drill Management for the Geologist" program in the exploration sector. This program is being developed by Central Metropolitan College of TAFE.

Completion Target *– ongoing and iterative- Progress Report December 2001.*

4. Promotion of a Positive Safety Culture

It is recommended that MOSHAB endorse the extension of the Thinksafe Minesafe program into the exploration drilling sector, utilising Glen Jakovich while he is still available.

A brochure (and poster) series can be developed, drawing upon the extensive range of issues contained in the Drill Hazards Report.

Completion Target *– June 2001*

J M Torlach
STATE MINING ENGINEER

1 May 2000

ZMS569BM/R

APPENDIX A1

PREVENTION OF MINING FATALITIES TASKFORCE
DRILLING HAZARDS SUB-COMMITTEE
TERMS OF REFERENCE

PRELIMINARY

The Taskforce resolved at its second meeting on Thursday 2 October 1997 to set up a sub-committee to deal with managing the risks associated with drilling rigs in use in the industry, in both the exploration and operating mine sectors.

The main focus is on the truck mounted rigs in rotary air blast (RAB) and reverse circulation (RC) drilling used on both exploration sites and for exploration and production on operating minesites.

However diamond (core) drilling and the larger production rotary drill rigs will require consideration on some aspects, in particular rod handling and worktable activities, as well as liquids and gases under pressure.

TECHNICAL AND OPERATING HAZARDS

- **Rod Handling Systems**
  Examine existing systems and practices and recommend design and operating safeguards.

  Work table systems and making and breaking drill rod joints to be included in this aspect.

- **Protection of Operators from Rotating Parts**
  Examine existing systems and practices and recommend design and operating safeguards. The primary focus is on rotating drill rod systems, but ancillary components may be included.

- **High Operating Pressure for RAB and RC Drilling in particular**
  Examine the practice of using increasingly higher air pressures for deeper RC drilling, and determine a prudent and safe air pressure limit for this type of drilling.

  The standard of hosing, hose couplings and hose restraints to be included in this review, as well as the wear factors on drill cuttings, collection hoses and fittings. The extent to which hard plumbing design can minimise or eliminate flexible hosing for high-pressure reticulation also to be included.

- **Collection Systems for Drill Cuttings and Exhaust Discharge Systems**
  Review the integrity of existing systems and recommend safe standard designs and practices.

- **Noise and Dust Attenuation**
  Examine existing designs and practices and recommend design improvement and remedial action.

CONCLUSION

Recommendations for an action plan for the industry with a firm timeframe to be given for each element.

The recommendations should address actions by manufacturers, drilling contractors and client companies.

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DRILLING HAZARDS REPORT

PART B

DRILLING HAZARDS SUB-COMMITTEE REPORT

PART 1

1. INTRODUCTION – FORMATION OF THE SUB-COMMITTEE

TERMS OF REFERENCE

The terms of reference for the sub-committee were set by the Prevention of Mining Fatalities Task force and are contained in the *Report on the Inquiry into Fatalities in the Western Australian Mining Industry*. The following has been taken directly from Appendix D of that report.

PRELIMINARY

The task force resolved at it's second meeting on Thursday 2 October 1997 to set up a sub-committee to deal with managing risks associated with drilling rigs in use in the industry, in both the exploration and operating mine sectors.

The main focus is on the truck mounted rigs in rotary air blast (RAB) and reverse circulation (RC) drilling used on both exploration sites and for exploration and production on operating mine sites.

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  Examine existing systems and practices and recommend design and operating safeguards. The primary focus is on rotating drill rod systems, but ancillary components may be included.

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  Examine the practice of using increasingly higher air pressures for deeper RC drilling, and determine a prudent and safe air pressure limit for this type of drilling

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  Review the integrity of existing systems and recommend safe standard designs and practices.

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  Examine existing designs and practices and recommend design improvement and remedial action.

CONCLUSION

Recommendations for an action plan for the industry with a firm time frame to be given for each element.

The recommendations should address actions by manufacturers, drilling contractors and client companies.

LIST OF MEMBERS - Original Sub-Committee Members

John McGee
Mechanical engineer and
Special Inspector of Mines, Machinery.
Department of Minerals and Energy WA
Chairman of the Drilling Hazards Sub-Committee

Brett Boneham
Special Inspector of Mines, Machinery.
Department of Minerals and Energy WA

John Emerson
Manager, Drilling Services
WMC Exploration

Bob Fahey
Drilling Superintendent
BHP Minerals, Exploration

Richard Reed
Trades and Labor Council WA
Drill Leading Hand
Roche Bros Contracting

David Stevens
Drilling Consultant
Australian Drilling Industry Association

Additional sub-committee members

Michael Martin
General Manager
Drilltorque (Aust) P/L

Phil Smith
Loss Control and Environment Adviser
WMC Exploration

OBJECTIVES AND SCOPE OF THE SUB-COMMITTEE

The sub-committee was asked to address “Technical and Operating Hazards” specifically – Rod handling systems; protection of operators from rotating parts; high operating pressures for RAB and RC drilling; collection systems for drill cuttings and exhaust discharge systems; noise and dust attenuation.

During the course of the first two meetings the sub-committee added three more items to the list – shut down facilities; prevention of fires and fire fighting; and training.

PROCESS ADOPTED DURING MEETINGS

Meetings were held each month beginning January 1998 until October when extra meetings were scheduled in order to prepare the final report.

Each member of the sub-committee accepted responsibility to define the hazards for one or two groupings and to then prepare recommendations for actions required of (a) manufacturers, (b) drilling contractors, (c) mining companies.

The responsibilities accepted by the members were:

Fires and fire fighting	John McGee
Noise attenuation	John McGee
Training	David Stevens
Shut down facilities	Richard Reed
High operating pressures	Richard Reed
Collection systems for drill cuttings and exhaust discharge systems	Brett Boneham
Dust attenuation	Brett Boneham
Protection from rotating parts	John Emerson
Rod handling systems	Bob Fahey

FORMAT OF THE FINAL REPORT

The task force required the sub-committee to present an interim report during May and a final report during November 1998.

During August the sub-committee requested extra time from the task force to prepare and present the final report. A need to consult the industry via public meetings had been recognised and two meetings were organised in Perth during November. The first meeting was to address ADIA members exclusively, and the second to address all other interested parties.

The task force agreed that the final report could therefore be presented in two parts. Part one was to contain the bulk of the report including some recommendations of a general nature. This part was to be presented in November 1998. Part two was to contain the specific recommendations that were to be discussed with the industry and modified as agreed at the public meetings. This part was to be presented in January 1999.

2. EXECUTIVE SUMMARY

TERMS OF REFERENCE

In October 1997 the Prevention of Mining Fatalities Task Force resolved to set up a Drilling Hazards Sub-committee to deal with managing risks associated with drilling rigs in exploration, and operation, in use in the mining industry.

The sub-committee was to focus upon technical and operating hazards in

- Rod handling systems.
- Protection of operators from rotating parts.
- High Operating pressures for RAB and RC drilling.
- Collection systems for drill cuttings and exhaust discharge systems.
- Noise and dust attenuation.

The sub-committee should address actions by manufacturers, drilling contractors, and client companies.

MEETINGS

The sub-committee met regularly each month as well as some special meetings called to discuss specific issues.

Some additions were made to the original terms of reference to include

- Prevention of fires and fire fighting
- Shut down facilities
- Training

REPORT FORMAT

An interim report was presented to the task force in May 1998.

The task force agreed that the final report could be presented in two parts.

- Part one was to be presented in November 1998.
  This part was to contain the bulk of the report including some recommendations of a general nature.
- Part two was to be presented in January 1999.
  This part was to contain the specific recommendations following discussions of the sub-committee recommendations at meetings of the ADIA members on 17th November 1998, and of the general public on 18th November 1998.

PRECIS OF THE RECOMMENDATIONS

These recommendations are for **Part 1** only

1. An Australian Standard be developed for drill rigs similar to the European Standard EN 791 Drill rigs – Safety.
2. Formal research be carried out to investigate the thread forms for all drill pipes and rods for current and likely drilling depths and at current and likely air pressures. Also consider discard criteria for pipes and rods, and material specifications.
3. Formal research be developed and carried out for whip checks. This research to include correct design of internal devices and their end restraints; external stockings and their end restraints; hose end attachments.
4. Formal research be developed and carried out for booster discharge hoses. This research to include correct design of hoses under operating conditions of internal and external temperature, pressure, pressure pulses, hose end attachments.
5. Formal research be developed and carried out to specify air pressure regulators for sample hose connections. Also to check internal wear on sample hoses.
6. All mining, exploration and contracting companies to improve accident and incident reports. This is to include the timeliness and accuracy of the reports. Also to include the reporting of all vehicle accidents.

TIME FRAME FOR IMPLEMENTATION

The implementation of these recommendations should begin immediately the recommendations are agreed to by MOSHAB.

3. REVIEWS

WA ACCIDENT STATISTICS

There are several pages of accident statistics following. The first group deals with the "Nature of Injuries" sustained by production drilling employees and exploration drilling employees which are then compared to all surface metalliferous employees. It is generally accepted that a fracture is a serious injury, and the exploration employees have a far higher percentage of fractures than either of the other two groups.

The second group deals with the "Injuries by Part of Body". Exploration drilling employees suffer a disproportionately high percentage of hand injuries when compared to the other groups.

The third group deals with the "Injuries by Type". Exploration drilling employees incur a disproportionately high percentage of "caught/by between" injuries.

The fourth is a simple statement that "Approximately 61 per cent of drilling injuries are sustained by drillers' assistants".

Given the nature of the work undertaken by drilling crews it should not be a surprise to see these statistics.

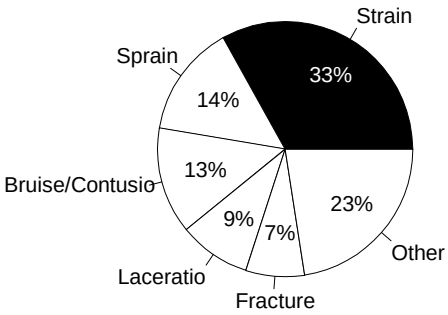
The first chart illustrates "Drilling Incidents by Type". Numbers of incidents are plotted against the type of incident. Very obviously the "caught by between" numbers are almost double the next most serious of "struck by rods".

The second chart examines the breakdown of the "caught by between" incidents. Again it is not surprising that there, most accidents occur in conjunction with drill rods.

The third chart examines the "Lost Time Injury Frequency Rate". The exploration drilling frequency rate is almost 69% over and above the drilling total.

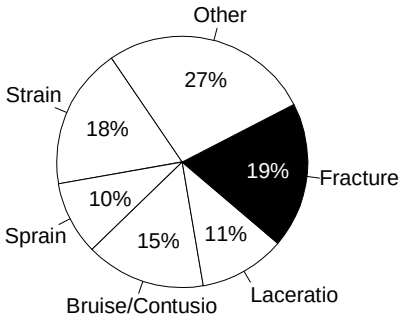
The fourth chart examines the "Lost Time Injury Incidence Rate". Once again the rate for exploration drilling far exceeds the production drilling rate and the surface metalliferous rate. There have been improvements in the rates for both exploration drilling and production drilling, but in both cases only after mid term deteriorations, whereas the rate for surface metalliferous incidents has shown a pleasing downward trend. It is far too early to make predictions about the future trends.

PRODUCTION DRILLING

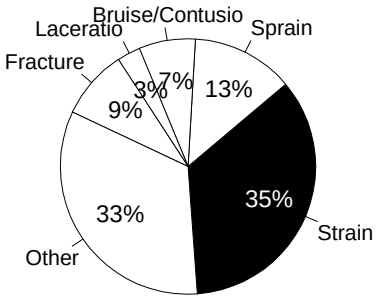


NATURE OF INJURIES

EXPLORATION DRILLING

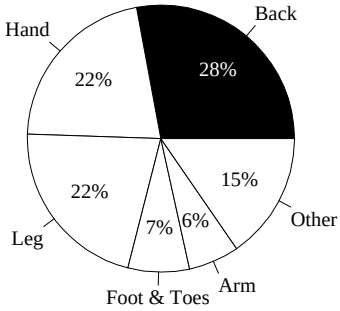


SURFACE METALLIFEROUS



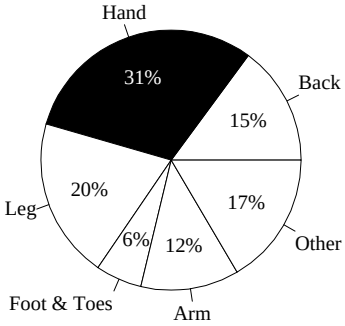
SOURCE AXTAT DME

PRODUCTION DRILLING



INJURIES BY PART OF BODY

EXPLORATION DRILLING



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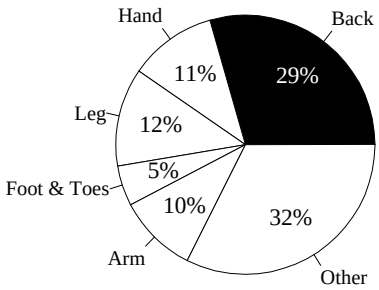
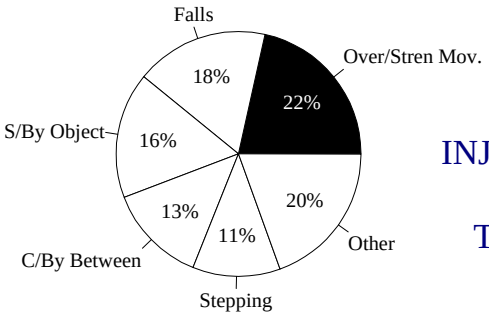


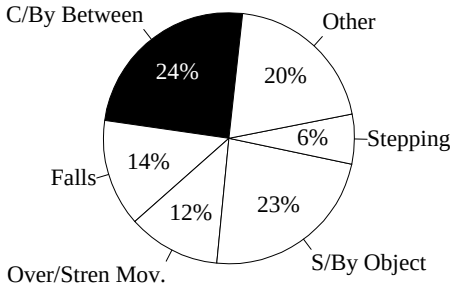
SOURCE AXTAT DME

PRODUCTION DRILLING

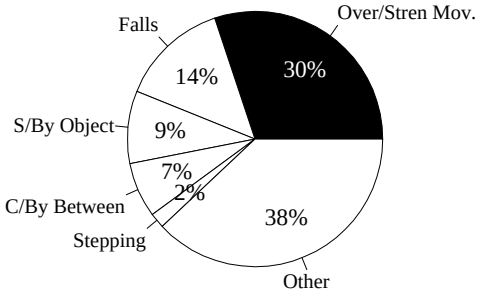


INJURIES BY TYPE

EXPLORATION DRILLING



SURFACE METALLIFEROUS

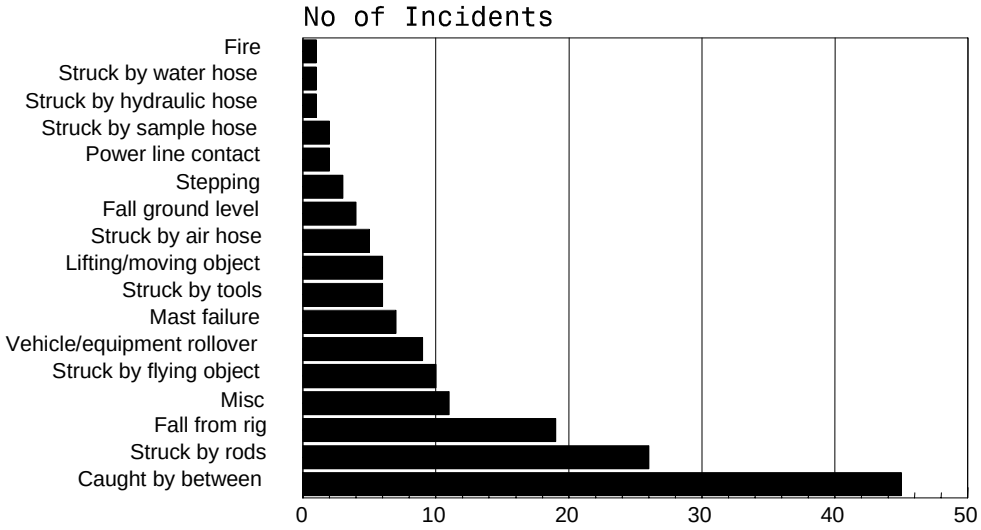


SOURCE AXTAT DME

INJURIES BY OCCUPATION

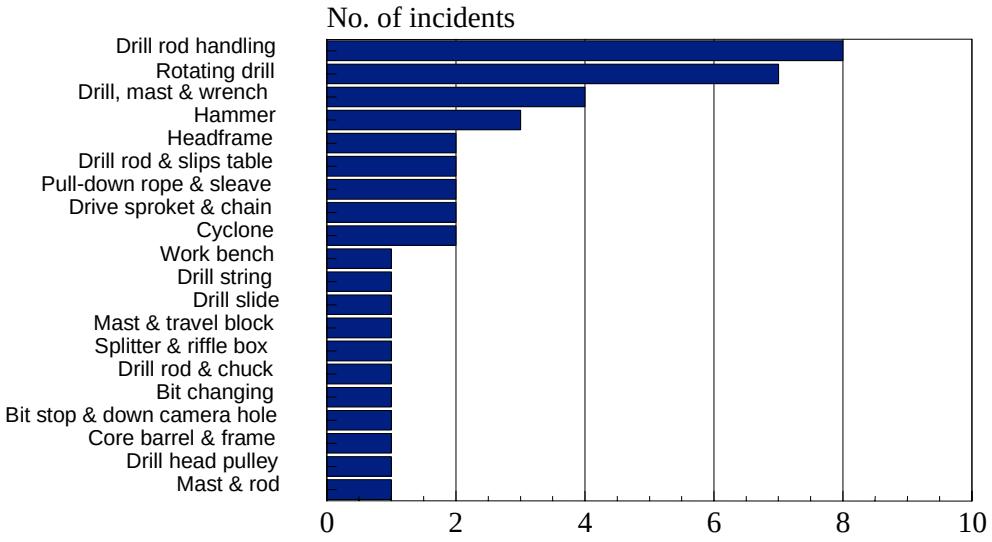
Approximately 61 percent of drilling injuries are sustained by drillers' assistants

Drilling Incidents by Type



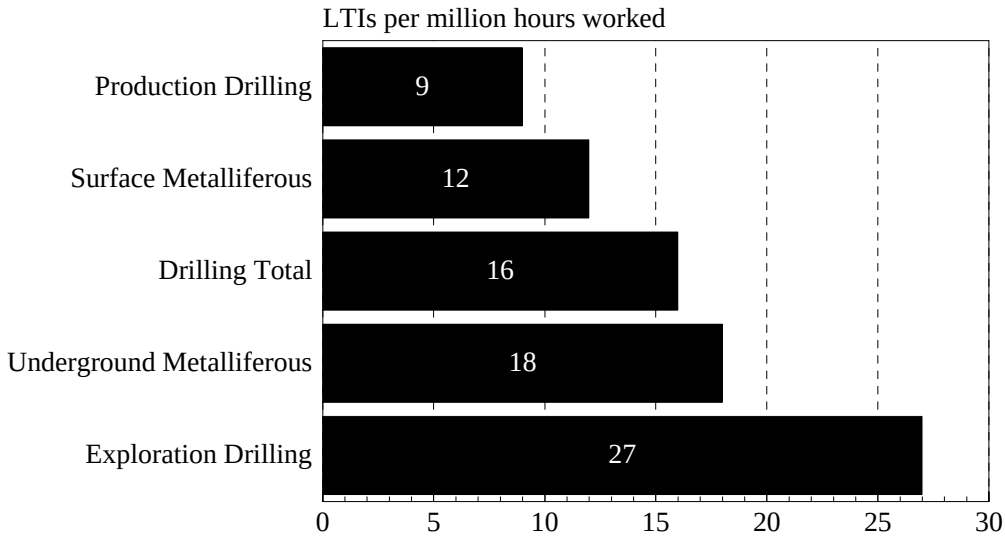
Drilling Incidents by Type

Caught by between



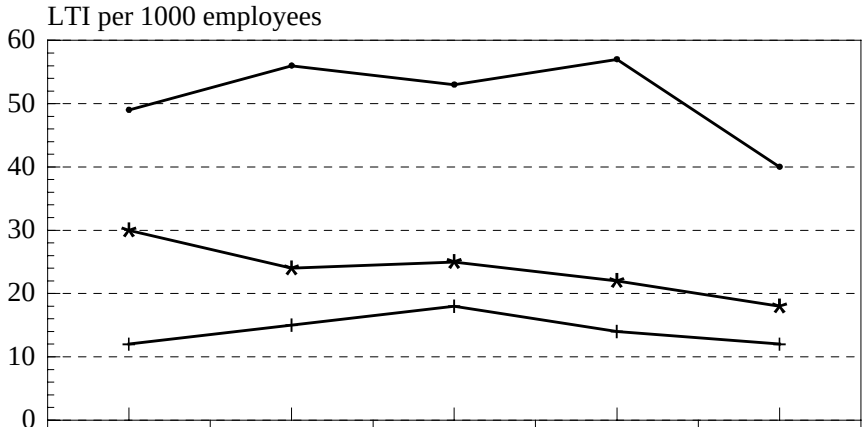
SOURCE: DME FYI REPORTS

LOST TIME INJURY FREQUENCY RATE



SOURCE AXTAT DME

LOST TIME INJURY INCIDENCE RATE



	1993	1994	1995	1996	1997
Exploration Drilling	49	56	53	57	40
Production Drilling	12	15	18	14	12
Surface Metalliferous	30	24	25	22	18

SOURCE AXTAT DME

NSW AND NT ACCIDENT STATISTICS

During the course of the sub-committee meetings, letters were written to the Chief inspectors for mining in all states and the Northern Territory requesting information from them on any of the topics of the terms of reference of this sub-committee, and for statistics on accidents and incidents within their inspectorates.

The information received about the statistics was, as expected, in a slightly different form to that kept by the WA Dept of Minerals and Energy. However, the statistics were adjusted to a similar form as WA and these adjusted statistics are recorded on the next three pages.

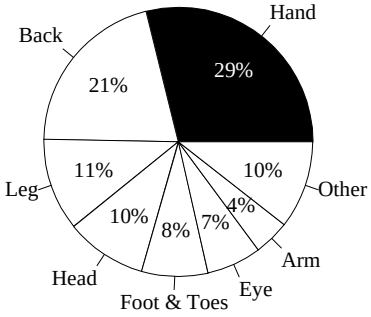
It is very obvious that the “Drilling Accidents by Part of Body” charts show quite marked differences between the three respondents.

It is also very obvious that the “Drilling Accidents by Type” charts show quite marked differences between the three respondents.

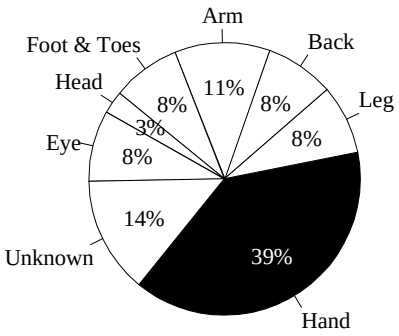
And once again there are marked differences between the charts for “ Drilling Accidents by Nature of Injury”. In this case the response by the Northern Territory could not be converted to similar statistics as for WA and NSW.

DRILLING ACCIDENTS BY PART OF BODY

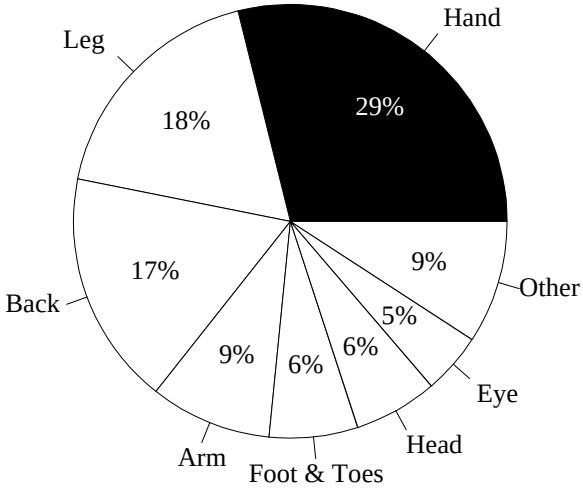
Western Australia 1987 - 97



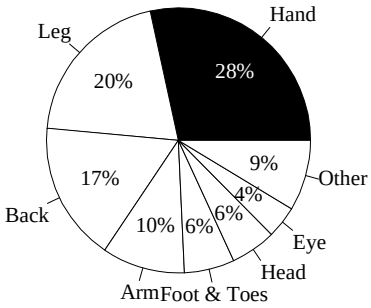
New South Wales 1985 – 1997



Northern Territory 1990 – 1997

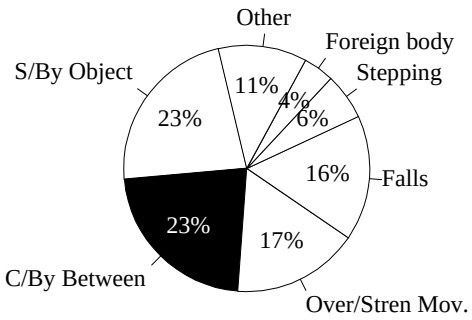


States Combined 1985 – 1997

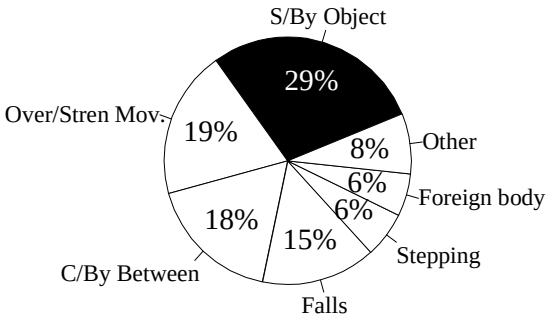


DRILLING ACCIDENTS BY TYPE

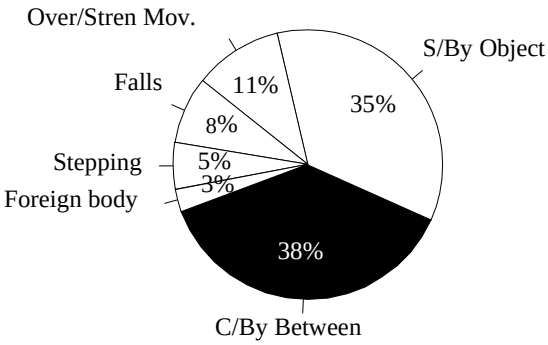
Western Australia 1987 - 97



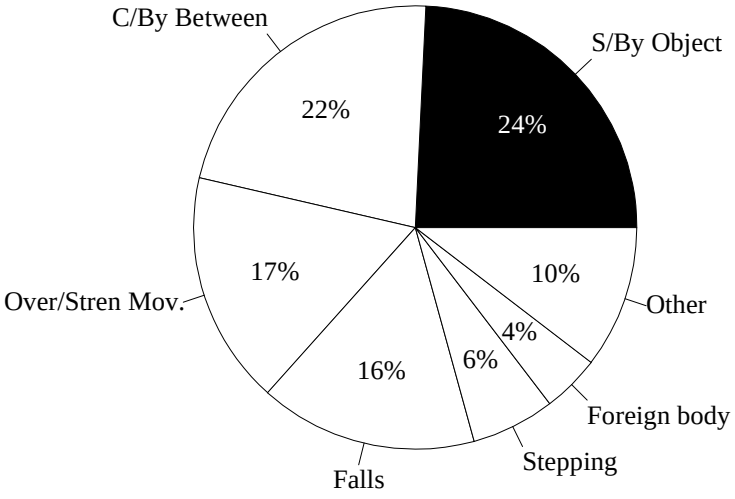
New South Wales 1985 – 1997



Northern Territory 1990 – 1997

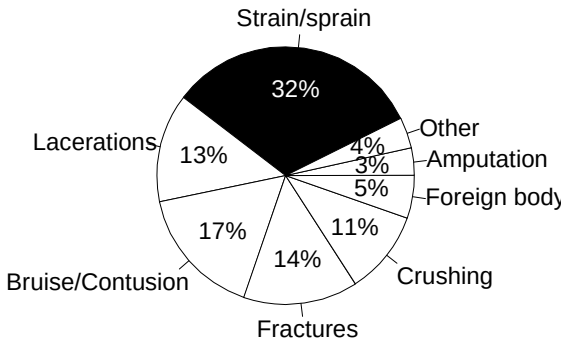


States Combined 1985 - 1997

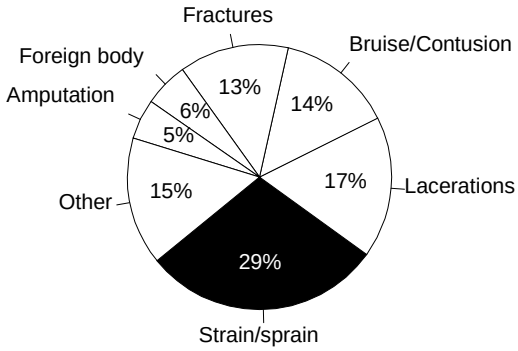


DRILLING ACCIDENTS BY NATURE OF INJURY

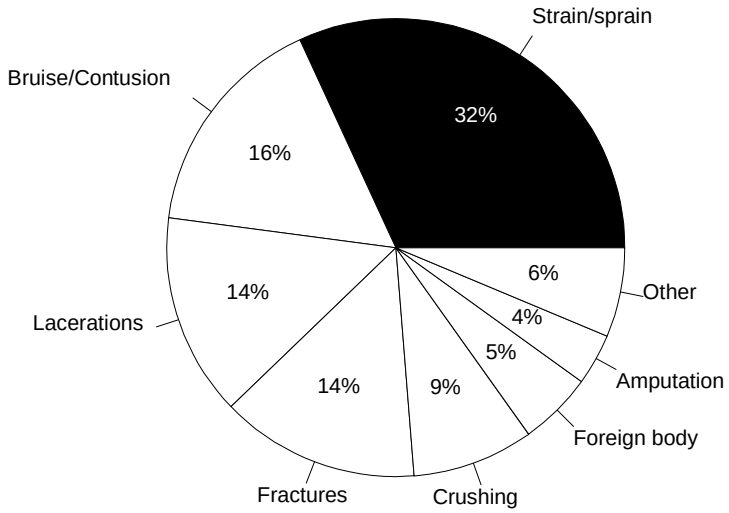
Western Australia 1987 - 97



New South Wales 1985 – 1997



States Combined 1985 - 1997



4. SUMMARY OF FINDINGS

There will be two parts to the Final Report. The findings below are of a more general nature than the findings contained in part two. Readers should ensure they read the recommendations of both parts.

OUTLINE OF MAIN FINDINGS

An Australian Standard for Drill Rigs - Safety

During the course of the sub-committee meetings reference was made to the European standard EN 791 DRILL RIGS – SAFETY quite often. This standard is very comprehensive. It deals with the following: Drilling equipment, percussion drilling, rotary drilling, safety of machines, dangerous machines, hazards, safety measures, operating stations, control devices, brakes, safety devices, stability, fire protection, engine noise, vibration, marking, name plates, technical notices.

The sub-committee considers that this standard should be used as the basis for an Australian Standard dealing with similar issues.

Recommendation
Standards Australia be requested to develop a standard along the lines of EN 791 and including items from the "hazards and recommendations" section of the Final Report – Part Two.

An investigation of drill pipes, rods and threads

The sub-committee considers there are too many threads available for drill pipes and rods. Research should be carried out to determine the best thread forms for each application, discard criteria for pipes and rods, and quality and strength of pipe and rod materials. This research should take into account likely future drilling conditions such as air pressures, drilling depth etc. "Go, No-Go" gauges need to be specified and developed for each thread form.

Recommendation
Formal research be carried out to investigate the thread forms for drill pipes and rods for current and likely drilling depths, at current and likely air pressures. The research should also consider the discard criteria of the drill pipes under the present and likely air pressures and the material specifications. This research to include "Go, No-Go" gauges for each thread form.

Whipchecks

The work done and reported by Mulligan and Ranasinghe in "Restraint Devices for High Pressure Flexible Air Hoses" – see List of References in Final Report – part 2, needs to be continued and extended. This report and the accompanying video should be read and viewed by all people concerned with safety in the use of air hoses.

The sub-committee considers more work needs to be done to more precisely determine the levels of forces and energies involved in the sudden release of all regularly used pressurised hoses. Additionally, the research should expand to include air pressures likely to be in use in the next five years. This research would lead to correct design of internal whipchecks and their end restraints, external stockings and their end restraints, and hose end attachments.

Recommendation
Formal research be developed and carried out for whipchecks. This research is to lead to the correct design of internal whipcheck cables and the end restraints; external stockings and their end restraints; hose end attachments. The research should include air pressures likely to be in use in the next five years.

Booster Hoses

The sub-committee was unable to find any references to research carried out into the development of booster discharge hoses. These hoses are subject to considerable internal and external temperature variations, and to considerable and fluctuating internal pressures. More work needs to be done to ensure the hoses in current use are suitable. The work should also extend to the pressures likely to be in use in the next five years.

Recommendation
Formal research be developed and carried out for booster hoses. This research is to lead to a check of the hoses and hose ends under present operating conditions and be extended to include likely operating conditions in five years time.

Sample Hoses

Sample hoses remain the weak link in the chain from drill bit to sample collection. These hoses are subject to considerable variations in temperature and pressure, as well as considerable internal wear due to abrasion caused by the cuttings. Devices have been developed to allow the operator to attempt to clear blockages by applying booster pressures to hoses quite inadequate to accept such pressures. Again the reader is referred to the Mulligan/Ranasinghe report to get an illustration of the dangers involved with escaping compressed air. The drilling industry is of the opinion that being able to divert some high-pressure air to sample hoses aids in keeping blockages to a minimum. Work needs to be done to ensure any air pressure diverted to sample hoses is regulated to predetermined pressures. No work appears to have been done to enable the condition of these hoses to be determined externally other than by the pinch test. It would be in the interests of safety for a method to be developed.

Recommendation
Formal research be developed and carried out specifying air regulators for sample hose connections. This research should include work to develop an external method of checking the internal condition of sample hoses.

Accident and Incident Reports

The number of accident and incident reports received by the Dept of Minerals and Energy is thought to be too low. Anecdotal evidence indicates there are far more of both categories than are reported and recorded. Anecdotal evidence also indicates there are far more vehicle related accidents and incidents than are recorded. The Act and the Regulations require correct and accurate reporting of all accidents.

Recommendations
All mining, exploration and contracting companies are to improve accident and incident reports. This is to include the timeliness and accuracy of these reports. All vehicle accidents, including those that occur travelling to and from a site, as well as those that occur on a site are to be included.

SAFETY CULTURE

The Existing Safety Culture And How It Could Be Improved (David Stevens/ John Emerson)

The WA State Mining Engineer, Jim Torlach, writing the Guest Editorial for the June 1998 issue of Minesafe and commenting on the “Report on the Inquiry into Fatalities” commented in part:

> “The motivation to improve must come from within each enterprise, starting with leadership and commitment from the top.”

> "Two factors are evident ….. These are, tolerance of identified risks, and failure to appreciate the severity of risks, on the part of individuals and organisations involved."

"What is required to improve safety culture?"

"Three basic elements are essential for efficient and safe performance:

- Knowledge
- Capacity
- Motivation

"**Motivation** remains the critical key to improved performance. There must be strong leadership, demonstrated management commitment, trust and co-operation between employers and employees, and a belief that all injuries are preventable. This must be supported by a genuinely held belief that real efficiency and productivity is achievable only where safe performance is the primary driver of the production function."

Dr Robert McLellan, of the Australian Safety Centre, in a paper presented at a recent Safety in Mining conference stated:

> "…. and it should be noted that agencies can demand compliance against regulations and codes of practice but cannot legislate, nor set standards, for beliefs, values, attitudes and motivation."

McLellan goes on to say:

> "The expression 'safety culture' is harder to define. Perhaps the best way to deal with the concept is in terms of its outcomes or effects – not to describe what it is, but what it does. An organisation with a positive or good health and safety culture is one in which its people are competent and have strongly held safety values <u>which they put into practice.</u>

Tom Ord of Theiss Contractors, at the same conference stated:

> "The fundamental component of competence in health and safety management is sometimes overlooked, but is one of the most obvious causes of incidents. Competence needs to be addressed at two levels; management and workers. …….. Competence of people is a fundamental requirement of any health and safety management system."

Ord continues:

> ……. "The attitude of people is influenced by the organisations culture, values and beliefs. Organisations which have a strong safety culture will generally be more successful in influencing it's peoples attitudes. Behavioural influences are created through –
>
> - involvement of employees in decision making
> - goal setting
> - breaking down cultural and class barriers
> - respect for one another
> - teamwork
>
> "The standard of the working environment is generally a direct result of influences such as <u>leadership</u> and <u>behaviour</u>."

While much of the foregoing has been specifically written for the mining industry, it holds true for the drilling industry.

Certainly, in all of the surveys carried out among drilling contractors, the message has come through loud and clear that training, experience and competence is a fundamental issue in safe operations.

To improve the existing Safety Culture that currently exists within the drilling industry it must be recognised and accepted by everyone in the industry that:

- All accidents are preventable.
- A belief that no business objective takes priority over safety and health.
- Individuals have responsibilities and accountabilities in managing safety and health.
- All hazards can be identified and managed at all levels.
- Legal obligations are the foundation of the safety and health standards.

- They integrate people, procedures and equipment to an incident free workplace.
- They must achieve stated safety and health outcome indicators with actual number and rates.

To make the above happen, the current accepted behaviour of the people involved in the drilling industry must be changed. This requires the development of a "COLLABORATIVE ENVIRONMENT" between all parties.

A Collaborative Environment or Trust consists of:
- Respect: treating people with dignity.
- Consistency: in management, no surprises, competency.
- Openness: sharing of ideas and information, teamwork.
- Honesty: truthfulness in all dealings.

The safety culture of an organisation is influenced by the:
- Commitment of its management.
- Leadership of its Directors.
- Training it provides to all levels of the organisation.
- Competence of management and employees.
- Behaviour patterns of management and employees.

These points are where the Culture can be improved.

MINING AND QUARRYING OCCUPATIONAL HEALTH AND SAFETY COMMITTEE – MAQOHSC

This committee is a Ministerial Committee with employer, employee, and government representation. The committee has funds available to support and promote OH&S practices, education in OH&S, prevention and alleviation and treatment of disabilities, and improvement of OH&S, in the mining and quarrying industries in South Australia.

The following has been copied from the "PROJECT GRANTS – GUIDELINES FOR EXPRESSIONS OF INTEREST FORM" obtained from the committee at

100 Waymouth Street, Adelaide SA
or
GPO Box 2668,
SA 5001
DX 660, Adelaide
Attention Jane Liggins
Phone 08 8233 2002, Fax 08 8233 2223

"The Mining and Quarrying Occupational Health and Safety Committee is a tripartite body established under the Workers Rehabilitation and Compensation Act 1986. The Committee's mandate is to promote occupational health and safety and prevent injury and disease in the mining and quarrying industry. The most important function of the Mining and Quarrying Occupational Health and Safety Committee is to administer expenditure of the Mining and Quarrying Industries Fund.

This fund was originally set up in 1941 under the Workmen's Compensation (Silicosis) Scheme, administered by the Silicosis Committee. Interest on the investments of this fund is used to fund Committee initiatives.

The Committee acknowledges the importance of the co-operation and involvement of all relevant parties in improving health and safety in mines and quarries, and reflecting this, the Committee's work has the following emphasis:
- *Working with all groups in the industry, that is, employers and employer organisations, workers and unions, government bodies, health and safety professionals and others.*
- *Fostering co-operation between these groups in addressing the prevention of injury and disease and the safe rehabilitation of injured workers.*

THE MINING AND QUARRYING PROJECT GRANTS SCHEME

The Mining and Quarrying Occupational Health and Safety Committee sponsors initiatives which significantly contribute to the field of occupational health and safety, injury management or the return to work of injured workers in the mining and quarrying industry.

Successful applications will be required to demonstrate their contribution to the committee's mission in one or more of the priority areas identified for targeting.

Applications are required to demonstrate relevance to the work place and have the support of industry parties.

The special needs of non-English speaking background workers with low literacy levels should be taken into consideration within any proposal."

If any companies consider they have proposals that may meet the criteria of the Mining and Quarrying Occupational Health and Safety Committee of South Australia they should contact the Committee at the above address.

WHIPCHECK REPORT SUMMARY

(The following summary has been taken from the original prepared by Mr Bob Mulligan of ISAS. It is reprinted here with his approval).

High pressure hose restraint devices commonly known as whipchecks are widely used in the mining industry. Their function is to restrain the hose in the event of failure of the hose or coupling. Despite the fitting of these devices, several accidents have occurred in recent years, some of which have resulted in serious injury to personnel.

Investigative work carried out in 1995 on internal whipchecks, indicated that a 6mm internal whipcheck fitted to a 50mm hose could withstand the forces released on failure of the hose at pressures up to 80 bar, with flow rates as high as 1000cfm.

Concerns have been raised that these internal whipchecks could cause damage to the internal lining of a hose, however a program of regular inspection of hoses fitted with internal whipchecks has not revealed any signs of advanced wear or damage.

Internal whipchecks are obviously unsuitable for use in sample carrying hoses. Such hoses are more likely to fail at, or close to, hose couplings. These hoses should therefore be fitted with external whipchecks.

Following a serious accident in June 1997 in which the external whipcheck failed, it was decided that an investigation be carried out to try to determine the reasons for the failure of these safety devices. A test rig was made which permitted release of a hose and coupling under pressure. The purpose of the tests was firstly, to measure the forces on whipchecks when a coupling parted and secondly, to study the effectiveness of different styles of restraints in preventing hose whipping.

The initial series of tests attempted to measure forces by interposing a load cell between the whipcheck and its fixing. However the forces measured were found to be far lower than expected. Notwithstanding this one of the whipchecks tested failed on application of a load measured at 65 kg. On closer inspection, it was discovered that the wire rope had been cut by the sharp edges on the coupling.

A second series of tests was then carried out in two parts. The first part of the test consisted of a measurement of forces at the coupling using a special fixture. The second part of the test was to study the effectiveness of different styles of whipchecks. This was done by capturing the movement of the hose after release on slow motion video for later evaluation. The whipchecks tested included a single "sling" type whipcheck, two "sling" type whipchecks used together, a single leg "cable stocking" type whipcheck and a two leg "cable stocking" type whipcheck.

Major conclusions drawn from these tests were:-

- The force required to restrain a hose is greatest when the hose has not moved at all. As the hose starts moving the force required decreases to a minimum value before increasing again.
- A number of commonly held beliefs were found to be invalid, these are listed in the report.
- Currently available whipchecks are unlikely to pull apart. They are more likely to be cut on sharp steel edges.
- Internal whipchecks are the most suitable restraint device for clean air hoses.
- Two leg "cable stocking" type whipchecks were most effective in reducing hose whipping.

The report concludes by making recommendations on the manufacture, selection and fitting of whipchecks.

PERSONNEL ISSUES

Training and Experience (David Stevens)

Training, or, more precisely, the "lack of training", and the companion to lack of training, "lack of experience", are the two most often mentioned and readily identifiable safety issues raised across the widest cross section of employers in the drilling industry.

The most urgent need is for training at the entry level to the drilling industry, for two main reasons –

i. Anecdotal evidence suggests that a high proportion of incidents, accidents and injuries occur among new starters, particularly in their first three months of service;
ii. The attrition rate among new starters is often so great that the likelihood of having at least one relatively inexperienced offsider in any crew is quite high.

Currently, there is only one entry level training course available and this is a 12-day course offered by CMC TAFE. The content of this course is overseen by an industry advisory board and has received endorsement from the Australian Drilling Industry Association in Western Australia. While there is a practical element to the course and the course syllabus is widely accepted, it is perceived, in some quarters, to suffer from several structural shortcomings –

i. A course of this length would normally attract a fee of at least $ 600, to be self funding, and this is considered to be beyond the resources of many potential trainees;
ii. Where funds are garnered from government, it is felt that there would always be a proportion of trainees who would have no hope of gaining employment in the drilling industry;
iii. The throughput of 12 – 15 trainees every two months is nowhere near sufficient to satisfy the demand.

The message is that a 3-day short course is an urgent requirement. Ideally, a situation would exist where a training provider would advertise, interview, select, train and make available, at short notice, potential drill helpers, with a basic level of training, and MARCSTA, who satisfied client selection criteria, including drug screening and a police check.

The attrition rate in such a course could be high, particularly if indicative amounts of the required manual labour, in the form of rod handling and sample handling are included in the course. However, this is seen as more desirable than high attrition rate once new helpers reach site and start work.

It would be preferable that the Australian Drilling Industry Association is involved in such a training initiative, if for no other reason than to ensure that the course content was universally acceptable.

Some of the major contractors run their own entry level short courses. While there can certainly be no question about the quality of the content of these courses, there would be a clear benefit if they too, could be to an industry agreed level and content, to achieve industry wide acceptance and portability.

There would seem to be more likelihood of an employer funding ongoing training once a new recruit is established as a viable team member, with a demonstrated probability of remaining in employment.

The lack of training however, is not limited to new entrants to the industry, and the lack of training in human relations and man management, provided to drillers and supervisors, is probably a significant contributor to the high attrition rate among new starters.

There is an apparent lack of recognition, at these more advanced levels, that the high labour turnover at the entry level is counter productive, unsafe and expensive. A culture change among some drillers and supervisors is clearly needed, which is going to be difficult to achieve, and will require recognition by management that a problem exists, and then a dedicated effort to bring about change.

Driving skill is another area of concern as, all too often, a B class licence has been obtained on a Ford 350, with a 5 speed gearbox, and a multi speed gearbox in a heavy duty truck is quite beyond competence levels. The implementation of a system of multi level truck licences may overcome this problem.

Other areas where training is seen to be desirable are –

- Hazard identification;
- Risk assessment
- Risk control;
- Accident investigation;
- Communication.

5. DISCUSSION

HOW THE EXPECTED MOVE TO DEEPER DRILLING WITH HIGHER FLUID AND AIR PRESSURES MIGHT AFFECT SAFETY (DAVID STEVENS)

1. LIQUID CIRCULATION

Liquid circulation has been around for a very long time and has been used to drill some very deep holes.

Essentially, when drilling with fluid, the column of fluid inside the drill pipe is connected, at the bottom of the hole, across the face of the drill bit, to the column of fluid in the annulus between the outside of the pipe and the walls of the hole, to form a "U" tube.

In theory therefore, all that has to be overcome by the pump, is the friction involved in moving the two columns of fluid. This is simplistic, of course, as there are many other forces involved, including friction in the rods/pipe and the greater density of the fluid moving up, carrying the cuttings from the hole. These add up to pump the pressure required to move the column of fluid and keep it moving.

The flexible connection between pump and drill string is, generally, a length of high pressure hydraulic hose, with a capacity and specification to handle the likely pressures, flow rates and temperature of the fluid used.

A hazard can develop when a blockage occurs and the positive displacement pump, generally used in fluid drilling operations, produces a build up in pressure in the flexible line. Five safety initiatives would generally cope with this situation –

i. use of a suitable pressure relief valve on the discharge side of the pump;
ii. use of suitable hose that has a burst pressure above the rated pressure capacity of the pump;
iii. systematic checking of the hoses in use and the correct operation of the pressure relief valve and its setting;
iv. whip checks at the pump outlet and the swivel inlet;
v. an awareness of the potential hazard through training.

The hazards involved are usually well understood and safety management is, in general, good. Hoses and piping in use, given reasonable care and an intelligent replacement programme, are adequate and not subjected to pressures, flow rates or temperatures outside their design specifications.

2. AIR CIRCULATION

When drilling with air, a different situation develops, particularly when using a down the hole hammer, as two parameters become important, pressure and volume of air used.

Very broadly, as the hole is drilled deeper, greater air pressure is required to overcome the back pressure created by water and solids in the hole, so that productivity can be maintained. However, as a DTH Hammer requires a finite amount of compressed air to operate efficiently, as the pressure increases, so too must the inlet volume of air increase.

The potential hazards can, perhaps, be separated into Pressure, Volume and Temperature.

The effects on safety from these parameters are –

- Hoses in general used as air lines are hydraulic hoses, designed to handle the flow of hydraulic fluid at temperatures below 150 degrees C.
- The act of compressing air causes heat build up and, as the pressure increases, so too does the amount of heat generated.
- Where a primary compressor feeds compressed air into a booster compressor, already heated air becomes even hotter in the next stage of compression, and if pre-coolers and after coolers are not used, or are inefficient, the temperature of air entering the air delivery hose may be above the rated capacity.
- Where ambient temperatures, typical of the summer months in Australia, are high, the temperature of air entering the air delivery hose could be well above the rated capacity.
- When the air is discharged from the hammer, after activating the piston, it enters the return annulus to travel back to the surface. As it travels up the return annulus, and the back pressure decreases, the air expands back towards its original inlet volume.
- As the volume increases, so too does the velocity at which it travels in the return annulus. Where the original inlet volume is 1800 cfm, a not unusual situation, the calculated up hole velocity in a 2-inch return annulus, exceeds 70,000 feet per minute.
- As the return air also carries the drilled sample, the abrasion factor and wear rate on all components through which the high velocity, sample laden air travels, is very high.
- Even when venting to atmosphere, a compressor will continue to produce air at close to its rated pressure, which causes a burst hose to flail around unless adequately restrained.

The safety issues then are –

i. the capacity of hoses and piping used on the air delivery system to cope with the pressure involved, and the heat generated;
ii. the high wear rates on all components caused by the combination of abrasive cuttings and high velocities;
iii. the dangers of a blow out on the sample delivery hose;
iv. the adequacy of restraining devices used;
v. lack of training of crew members about the dangers and about management procedures;
vi. the lack of adequate maintenance of all lines carrying high pressure air;
vii. the use of inappropriate fittings relative to the pressures used and the types of hose carrying the air.
viii. overly long high pressure air delivery hoses;
ix. the dangers of blow up systems for clearing blockages in the sample delivery line;

PRODUCTION PRESSURES AND REMUNERATION SCHEMES (RICHARD REED)

(This topic is not strictly in the terms of reference of this sub-committee. However, it was strongly felt by most members that it would be apposite to make some remarks as the issue of personal safety is woven into the behaviour of all personnel around the rig. It can be seen from the DME AXTAT reports that drillers' offsiders sustain 61 % of drilling injuries. Therefore all issues that affect the safety of these offsiders should be discussed.)

Recently, several drillers' offsiders spoke out about their concerns:

- They felt that the offsiders were paid disproportionately less than drillers. Examples were given to illustrate offsiders, in many cases, earn about one third of the driller.
- They also felt the time an offsider had to spend before being promoted to driller was far too long.
- The isolation of many exploration contracts means drill crews may have to live in caravans and perform many other duties on top of their drill rig associated work. Many offsiders find better money, and easier work, in a different area of mining, where a fully supported camp is supplied.
- Roster systems are put in place by most drilling companies but are not followed.

There are two examples following that are not unusual:

- An offsider working 4 weeks on /1 week off roster was on his second day off when he was telephoned and then visited to ask to go back to work because the employer was short of offsiders.
- An offsider working 6 weeks on / 1 week off roster was asked to stay on for another week or two as the employer didn't have a replacement for him.

In both cases the offsiders spoke of considerable pressure put on them to comply with the companies' requests. Offsiders that did the excessive work were seen to be given advantages over those who complied with the roster system in place.

These conditions are held to be largely responsible for a high turnover of drillers' offsiders. Drillers have indicated this leads to often having at least one inexperienced offsider, and at times to having no offsider. This lack of trained and experienced personnel must have a significant effect on safety.

A huge improvement is achievable.

PRODUCTION PRESSURES AND REMUNERATION SCHEMES (DAVID STEVENS)

The Drilling Industry has, for many, many, years been an industry where bonus payments are the accepted norm and linked only to productivity. It is seen as an industry where high levels of earning may be achieved, through overtime and bonus payments.

The retention rate in the industry is not great and, often, the long hours of work in isolated or semi isolated areas is seen to be worthwhile to build a substantial bank balance in a short time frame. This attitude can lead to a drive for greater productivity, which can impact on safety, particularly with less experienced and relatively untrained personnel.

Further, in times of falling prices for drilling, there can be pressure to increase productivity at the expense of safe practice and good maintenance. This is clearly unacceptable, but the instances cited of client companies consistently accepting the low bid, suggests that there is a lack of understanding about the role of the Principal Employer and about what contract prices are economically viable, which increases the market pressure to lower prices. This, in turn, leads to a need to increase production to remain in business.

Bonus schemes can be devised to foster better on site training and safer operations. These would reward better attitudes, penalise unsafe practices and, if they contribute to retention rates, would have a positive effect on the experience levels of drill helpers.

SHIFT WORK AND WORK CYCLES

There are a number of factors that contribute to the practice of long periods of field time. Among these are –

- If long field periods are worked, fewer employees are required. Where good people, particularly trained people, are in short supply, this can be a powerful incentive to work stints of 6 weeks, and longer, before a break.
- The cost of rotating crews can be high, particularly where air transport is used, so an motive exists to work longer periods between breaks.

Twelve-hour shifts are the rule rather than the exception and two twelve-hour shifts are common, particularly on core drills. Clearly rig utilisation is a key factor in job costing, so there is an inducement for this practice.

Of particular concern are the jobs where travel time between camp and rig is extended or where camp duties are required at the end of the shift. These elements can quite significantly extend the actual hours in a day.

There are many factors that contribute to fatigue, including the length of rostered time on, the quality of accommodation and the actual hours required per day. While there is insufficient evidence to positively identify 12-hour shifts and long rosters as having a detrimental effect on safety, fatigue must be a concern, just as it is in driving accidents.

The statistics for accidents in the drilling industry do not identify road accidents as job related, as they are generally dealt with by the police. There is a strong opinion that statistics relating to job related travel on the road should be collected, as there are a significant number of accidents involved. A proportion of these could very well be fatigue related. It is important that these factors be recognised and addressed.

6. CONCLUSION

THE ROLE OF THE AUSTRALIAN DRILLING INDUSTRY ASSOCIATION (JOHN EMERSON)

The Australian Drilling Industry Association is an incorporated body that represents the drilling industry throughout Australia with some 343 members in Western Australia, and over 700 members in total.

The secretariat is located in Melbourne and the Executive Officer is located there. A national Board of Directors consisting of 12 members, drawn from each state and from different categories of membership, is responsible for the federal affairs of the Association. In addition, each state has a Branch Management Committee. The federal board is headed by the National President and each state has a State President.

The objectives of the Associations are quite wide ranging and include the promotion of training and safety. Registered training courses include:

- The Safe and Productive Use of High Pressure Air
- Diamond Coring
- Well Screens and Gravel Packs
- Drilling Fluids
- Contaminated Sites

The association produces its own bi-monthly journal “Australian Drilling” which has a worldwide circulation approaching 5000. This magazine is recognised as a tool for communication within the industry.

In late 1997, the contents of Bulletin 31, issued by the Department of Minerals and Energy, were seen to be so serious that meetings were convened in both Perth and Kalgoorlie to discuss the ramifications. As a consequence, safety working groups were set up in both centres, to examine

ways in which the drilling industry in Western Australia could prepared self regulatory recommendations to remedy the problems causing concern to DOME.

In addition, coincidentally, four of the members on the MOSHAB Drilling Hazards Sub-committee are members of the ADIA and two of those members are office bearers, namely John Emerson, the Federal President, and David Stevens, the WA State President. Both of these Drilling Hazard Sub-committee members are also members of the ADIA Safety Working Group, as are the other ADIA members on the Drilling Hazards Sub-committee, Bob Fahey and Michael Martin.

The ADIA Safety Working Groups have been enjoined to produce "Guidelines for safe operations for the drilling industry in Western Australia", that can be given to the State Mining Engineer, who would then be able to ask client companies to recognise the guidelines and not employ a drilling contractor who does not embrace them.

The time frame for the completion of the guidelines is January 31, 1999.

THE ROLE OF THE PRINCIPAL EMPLOYERS AND THEIR RESPONSIBILITIES (JOHN McGEE)

Attention is drawn to the provisions of the Act in regard to employers' responsibilities:

- **Section 4** contains definitions that are applicable such as "employee", "employer", "exploration operations", "hazard", "inspector" (several types), "mine", "mining operations", "practicable", "principal employer", "workplace" etc.
- **Section 9** contains "duties of employers", "duties of employees", reporting of dangerous situations or occurrences", "duties of employers and self-employed persons", "duties of principal employers and managers", duties of manufacturers etc".

And attention is drawn to Part 6 of the Regulations in regard to other responsibilities, in particular:

- **Regulation 6.2** "Plant to be maintained and operated in a safe manner". This regulation is quite clear in the expression of safety requirements.

All employers must provide and maintain as far as is practicable a working environment in which the employees of each individual employer are not exposed to hazards.

Safety Bulletin number 31 issued by the Department on 17/9/97 is recommended for further reading to illustrate the failures of the drilling industry to look after it's most valuable resource.

THE ROLE OF THE DEPARTMENT OF MINERALS AND ENERGY (JOHN McGEE)

The Mines Safety and Inspection Act 1994 has given to the mines' inspectorates control of the regulatory aspects of the exploration drilling industry. This responsibility is added to the responsibilities already enjoyed by the inspectorates in operating mine production drilling. These responsibilities are concerned mainly with the safety and protection of all employees in the industry whether they are employed by operating companies, contracting companies or privately employed.

There are of course exploration and drilling companies that have accepted their responsibilities to ensure a hazard free working environment, just as there are companies who actively resist modernising and at the same time avoiding the provision of the facilities to ensure safety first. The industry overall has a great deal of improvement in front of it.

All employers in the industry must make themselves familiar with the provisions of the Mines Safety and Inspection Act 1994, and the Regulations 1995.

Once these recommendations have been reviewed and accepted by the Mines Occupational Safety and Health Advisory Board (MOSHAB) the Department will prepare "Guidelines for the Purchase, Operation and Maintenance of Surface Diesel Engined Drilling Equipment". The Department will also review the current draft audit document to reflect the recommendations of this sub-committee.

Consequently, all employers in the drilling industry must address the very well known hazards and to eliminate the accidents and injuries that are now so prevalent. Engineering solutions are available, or can be applied, to all aspects of rig design and manufacture such that the hazards no longer exist. Manufacturers can not do this alone. There must be a stated purchase requirement from the drilling contractor, and there must be a contract requirement from the exploration company and or mining company.

Departmental inspectors will be emphasizing continuous improvements. The audit document mentioned above will address the practical safety aspects, the planning and organisational aspects, and the management attitudes towards safety and towards continuing improvements.

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DRILLING HAZARDS REPORT

PART C

DRILLING HAZARDS SUB-COMMITTEE REPORT

PART 2

1. INTRODUCTION

FORMAT OF THE FINAL REPORT

The task force required the sub-committee to present an interim report during May and a final report during November 1998.

During August the sub-committee requested extra time from the task force to prepare and present the final report. A need to consult the industry via public meetings had been recognised and two meetings were organised in Perth during November. The first meeting was to address ADIA members exclusively, and the second to address all other interested parties.

The task force agreed that the final report could therefore be presented in two parts. Part one was to contain the bulk of the report including some recommendations of a general nature. This part was presented in November 1998. Part two was to contain the specific recommendations that were to be discussed with the industry and modified as agreed at the public meetings. This part was to be presented in January 1999 and is the topic of this report.

DISCUSSION ON THE ADIA MEETING HELD ON 17TH NOVEMBER 1998

(See advertisements in Appendix C2)

The following articles certainly refer to items that were discussed at this meeting. It must be pointed out that the contents were not strictly within the terms of reference of this sub-committee but the contents do closely align with the safety theme of the terms of reference.

ACCEPTING THE LOW BID (DAVID STEVENS)

As made manifestly clear at the open ADIA meeting on November 17, and in frequent communications from contractors, there is a very real concern that, among some client companies, the choice of contractor is driven entirely by price, despite requests at the tender stage for comprehensive documentation of safety management plans, written best practices and similar items.

The preparation of this sort of documentation is time consuming and expensive and a real improvement in safety takes management commitment, a clear understanding of goals, training and motivation of drill crews to work safely.

While, in the longer term, there should be cost savings in lower labour turnover, higher productivity and reduced workers compensation premiums, these are not enough to wholly offset the cost of implementing structures training programmes and a real commitment to working safely.

Many drilling contractors are making these commitments in the belief that their safety record, commitment to safety and professionalism will ensure their preferred status with client companies.

Clearly, all too frequently this is not the case, as there are just too many reports of the low bid being accepted from drilling contractors with less commitment to safety and professionalism.

No contractor would want to deny the right for a client company to make a commercial judgement, based on tendered prices. However, in the present climate of work shortage and rig surplus, few client companies are prepared to pay a premium for safety and professionalism, and tendered prices are being driven down by contractors desperate to keep rigs working.

There is a real concern that this will cause pressure on increasing productivity and cutting corners on maintenance, safety and training, to the detriment of all involved.

The choice of contractor based solely on price therefore is seen as demonstrating a lack of understanding of the role of the principal employer and a lack of real commitment to safe operations.

TRAINING OF GEOLOGISTS

The drilling industry has, for a long time, considered that there is a dire shortage of training of geologists and engineers about drilling.

In the context of this report, the role of geologists and engineers as representatives of the principal employer, makes it imperative that the responsibilities of these people under the Mines Regulations and the O H & S regulations, be clearly understood.

As the first job for many new graduates is to go out and "sit on a drill rig", there would be no better place to teach these responsibilities and requirements than in the universities and tertiary colleges.

However, merely understanding the requirements of the Regulations is not enough, without some understanding of the functions of drill rigs and some basic grounding in relevant drilling techniques.

It is considered that, as a minimum, the two-week entry-level course conducted by CMC TAFE would be a model of what is required as a basic grounding in drilling. This course contains a module on safety and has a practical element.

Other training would be required in relation to responsibilities under the Regulations.

In the broader context however, a need is seen for far wider training, to encompass specifics such as basic costing, basic hole deviation and deflection, HP air and contract management.

DISCUSSION ON THE PUBLIC MEETING HELD ON THE 18TH NOVEMBER 1998
See advertisements in Appendix D)

The public meeting held on the 18th November was less interesting than the meeting held the previous day for ADIA members only. At this public meeting it was hoped to have a large attendance of mining and exploration company representatives. The sub-committee was disappointed to have only six such representatives present. From the total of twenty-eight present seven were sub-committee members, thus leaving fifteen others most of whom were ADIA members who had attended the previous day. Some of the themes of the previous day were repeated, perhaps in the hope of generating discussion from those mining and exploration companies' representatives present, but this did not occur. Very little discussion did occur about the general safety aspects of the "hazards and recommendations".

2. EXECUTIVE SUMMARY

ROD HANDLING (DAVID STEVENS)

In Bulletin 31, rod handling was, quite correctly for the time, identified as an area where accidents were occurring too frequently.

It could be enlightening for an analysis to be carried out of the circumstances involved in these reported accidents, with particular reference to the experience and level of training of the injured employees, the types of rigs involved and the companies for whom the injured worked.

The "Me Tarzan" method of rod handling was, without doubt, unacceptable and potentially dangerous. However, there have been engineering solutions applied to the problems -

- The introduction of level work platforms all around the rig, eliminating the need for jumping from one to another;
- The introduction of dump masts, allowing rod handling to be carried out at ground level;
- The introduction of pivoting rod handling booms, mounted on top of the mast;
- The introduction of sound geometry to pick up points on hook and clam shell operations;
- In some instances, the introduction of mechanised rod handlers.

There has been an unfortunate concentrated focus on handling heavy RC drill pipe, which has led to an ill informed and precipitous demand in the contracts of some client companies, for mechanised rod handling.

The ramifications of these demands have not, it is believed, been adequately appreciated and there appears to be a misplaced focus on this one issue alone.

Matters to be considered include -

- The potential problems where a satellite console is used to control the rod loader, independent of the rig operator;
- The extra bulk of the mechanised rod handlers currently available;
- Space requirements on a site to allow the rod truck to be placed where the mechanised rod loader can readily pick up rods;
- Speed of operation;
- The alternatives if the mechanised rod loader breaks down;
- The requirements for a rod handler on a rig carrying out wireline drilling;
- Cost.

The introduction of mechanised rod loading for heavy R/C pipe should be a commercial decision by individual contractors, as it is industry consensus that a hook and clam shell is a safe method of operation when used with a pivoting pipe handling boom, suitable geometry and adequate training of personnel.

It should be borne in mind too, that there is more to rod handling than merely handling heavy R/C pipe. Make and break and the method of suspending pipe in the hole are other considerations of importance.

Furthermore, wireline drill rods can become very sharp on both the box and pin ends and need to be handled with care. Handled in 6, 9 and 12 metre lengths, wireline rods can be heavy and unwieldy, particularly when being "run out" to the front of the rig. The type of safety rod clamp used is also an area to be considered.

Wireline threads on hoist plugs, subjected to constant screwing and unscrewing in the process of tripping rods, can become worn quite quickly and, with the slight taper of Q series wireline rods, can pull out under load, with serious consequences.

The majority of RAB rods are handled manually and this presents a range of potential problems discrete to this type of drilling.

MANAGING THE INDUSTRY (JOHN EMERSON)

The tabling of Bulletin 31 provided the catalyst for a detailed examination of managing risks within the Drilling Industry in Western Australia.

After a review of all of the available safety and statistical information by the sub committee, it was obvious that the technical and operating hazards tabled in the Terms of Reference (Appendix D) do exist in the Drilling Industry and it also identified other hazards that were being experienced in the Industry. It was also noted that the same problems existed within the Industry in the other Australian States.

In applying a Loss Causation Model: most problems can be related to a Lack of Control.

- Lack of Control - Basic Causes - Immediate Causes - Incident - Loss

Relating this to the parties within the Drilling Industry and keeping in mind the terms of Reference, some of the issues that need to be addressed are:

1. Drilling Contractors

Work Cycles: These must be reduced to a realistic schedule which in particular would allow more married people to become long term employees, reduce fatigue and reduce staff turnover.
Work Hours: These must be monitored and should not exceed 12 hours including travelling to and from work.

Remuneration: A system should be introduced where less emphasis is placed on the production component of the remuneration package.

Journey Planning: The travelling to and from the work site or remote exploration site must be monitored.

Training: Drillers must be trained and certified in all aspect of the business, experience is but one aspect of the skills a Driller requires today. Other areas are People Management Skills, Communication Skills and Technical Knowledge. The CMC TAFE College and the ADIA are two bodies who provide accredited training in these areas.

Purchasing Policy: When purchasing equipment, adherence to a strict purchasing policy is necessary to ensure the equipment is built in accordance to a recognised Standard and will be suitable for the job in hand. This will also reduce the amount of retrofitting of components by the Contractor.

2. Mining Companies

Training: Company Managing Directors must be made aware of their responsibilities under "The Duty of Care". All Mining Company employees must be aware of their responsibilities. Project Geologists should have a basic understanding of the Principles of Drilling and Costs and Contractor Management. This should be incorporated as a one-semester subject in their degree. This could be developed from the current CMC TAFE Course.

The Lowest Bid: With the above training and awareness on their responsibilities under the "Duty of Care" this problem should be reduced as the Geology Manager would be aware of the downfall of using the Contractor with the lowest price, without considering their safety records, systems, equipment and personnel. Until this happens this problem will remain.

Drilling Program Proposal: To eliminate problems, involve the Drilling Contractors in the development stage of your drilling program. Their input at this stage could offer alternatives, problems resolved and possibly relate to a more cost-effective program.

Reporting of Incidents: For statistics to be of any value all incidents must be reported. It has been discussed that some Companies do not report all incidents and try to hide them. This practice must stop and Companies must be encouraged to report all incidents and near miss incidents as well. Using statistics only as a guide can be misleading. The "Safety Culture" of the Companies must include an investigative procedure, which will improve their safety performance.

3. Manufacturers

Standards: All work involved in manufacturing of equipment for the Drilling Industry to be to a recognised Standard that will satisfy the DME regulations.

4. Department of Minerals and Energy

Consistency: This Government body must be consistent in how it interprets and enforces the Mines Regulations.

The above points are important within the context of the Drilling Industry. However where changes are to be made to Government Regulations or Recommendations the ADIA (Australian Drilling Industry Association) must be involved. This body represents some 95% of the Mineral,

Geotechnical and Waterwell Sections of the Drilling Industry within Australia. Western Australia has 350 members registered. Without the endorsement of this Industry Association any changes or modifications would be meaningless.

PRECIS OF RECOMMENDATIONS FROM "HAZARDS AND RECOMMENDATIONS"

The recommendations for **Part 2** are far too comprehensive to be able to give a shortened version. The reader can only be directed to the relevant section of the "Hazards and Recommendations" on the following pages.

The recommendations contained in **Part 1** form part of the overall recommendations.

However there is one further recommendation that is not strictly within the terms of reference of this sub-committee. The depth of dissatisfaction felt by some contractors with mining and exploration company representatives with contract documents and with perceived dollars before safety attitudes could be addressed by good will on the part of both parties. This could come about by combined meetings of the parties with perhaps a third party chairman. This meeting is recommended by this sub-committee in the interests of improved safety.

3. HAZARDS AND RECOMMENDATIONS

This is the most important part of the report.

The members of the sub-committee have each accepted responsibility to prepare a list of hazards for sections of the various rig operations and to then prepare a list of recommendations for each hazard applying to (a) Manufacturers of the rigs, (b) Contracting companies or Operators of the rigs, and (c) Mining and Exploration companies for whom the drilling is to be done.

During the preparation of these lists it became apparent that a priority system would have to be specified and such a priority system has been developed. At the beginning of each recommendation a notation will be found with one of the following notations: (P1), (P2), (P3). These notations represent the degree of importance attached by the sub-committee members to each recommendation as follows:

(P1) = Actions to be undertaken immediately:
- Where a high degree of risk to personnel has been identified and existing technology is available.
- Where a high degree of risk to personnel has been identified and management systems are available.
- Where existing regulations require immediate action.

(P2) = Actions to be undertaken:
- Where some research, design, or modification is needed.
- Where budgets need to be developed.
- Where rigs may be in the field and impossible to modify immediately and interim remedial action must be done.

(P3) = Actions to be considered desirable for implementation in the future but not considered essential.

SPECIAL NOTE: DRILLING HAZARD SUB-COMMITTEE REPORT RECOMMENDATIONS

The Sub-Committee made 528 specific recommendations, which MOSHAB considered too lengthy to include in this *Drilling Hazard Report*.

MOSHAB drafted an *Executive Summary and Action Plan* for both Part 1 and Part 2 Reports of the Sub-Committee, which includes a review of these recommendations, and this forms Part A of this Report.

The original 528 recommendations are published separately and can be accessed through the web at www.dme.wa.gov.au.

4. CONCLUSION

THE ACT AND REGULATIONS

It is obvious that many mining and exploration companies could improve their knowledge of the requirements of the Mines Safety and Inspection Act and Regulations. This applies particularly with respect to exploration drilling activities. There also seems to be widespread belief that, once a drilling contractor has been appointed all responsibilities under the Act and Regulations are transferred to the drilling company. This is not the case and mining and exploration companies, and drilling companies would be well advised to make themselves familiar with the requirements of the Act and Regulations.

Special attention is drawn to Part 6 “SAFETY IN USING CERTAIN TYPES OF PLANT IN MINES” of the regulations.

RELATIONS BETWEEN MINING AND EXPLORATION COMPANIES AND DRILLING COMPANIES PUBLIC MEETING ON THE 18TH NOVEMBER 1998

Only six representatives of mining and exploration company personnel attended the public meeting on the 18th November to discuss the “hazards and recommendations” being proposed by this sub-committee. They were outnumbered by the members of the sub-committee, and considerably outnumbered by the members of the ADIA.

It is interesting to note that many of the ADIA members also attended the meeting held specifically for them the previous day. Mining and exploration companies missed a unique opportunity to discuss safety aspects of drilling operations with three other key players in the industry ie the DME inspectors, the drill rig manufacturers, and the drilling contractors. Opportunities like this do not come about frequently and they should not be missed when they do present themselves.

CONTRACT CONDITIONS

During the deliberations of this sub-committee it became apparent the relations between the mining and exploration companies and the contracting companies could be vastly improved. There were many complaints, illustrated with examples, of mining and exploration companies issuing contract tender documents containing many onerous clauses seemingly designed to exclude rather than to encourage participation. There were also clauses requiring processes that don’t yet exist such as automatic rod handling.

There are perceptions held by some contracting companies that the mining and exploration companies frequently send inexperienced and untrained supervisors to drill sites. These supervisors have not, in many instances, been inducted in correct site safety procedures and frequently behave in ways, which are contradictory to the expressed mining and exploration company safety requirements. A lot of these supervisors need to be inducted into the contracting company site safety procedures. There are also perceptions that mining and exploration companies put dollars before safety despite writing contracts expressing the contrary.

Considerable difficulties in satisfactory dust suppression are present when contracting companies collect dry samples as opposed to wet samples. A lot more effort needs to be put into dust suppression. Some effort is being expended by the manufacturers. At this stage it is not totally satisfactory, but a lot of this effort could be redirected if wet samples were requested instead of dry samples. The long-term health effects of workers being exposed to dust from the dry sampling process is not yet evident.

And one further item of concern was frequently expressed. It was felt there should be more co-operative consultation between the mining and exploration companies and the contracting companies early in the contract. Site inspections, agreement on site preparation procedures, and on clean up procedures prior to the commencement of drilling would be of benefit to the drilling industry in the short term and to the exploration industry in the long term.

A summary of the above seems to be that a standard contract document setting out all of the general contract conditions, with appendices for special site requirements could only benefit all concerned. The emphasis should be on requiring what is practicable.

FUTURE CONCERNS

Mechanised Rod Handling

An emphasis is being placed on mechanised rod handling. It is felt by some sub-committee members that manual handling, when the operators are properly trained, can be as effective and as safe. It is also felt that exclusions from contracts should not occur because the contractor does not always have access to mechanised rod handling.

None of the sub-committee members has any doubts that mechanised rod handling will eventually become the normal method, but at this stage the various designs are all in the early stages of development.

Compressed Air Pressures

Compressed air pressures are at present a concern because the sample hoses are generally not rated at the pressures that can be applied internally when blockages occur. This is even more concerning when hoses have been in use for any time at all because internal wear occurs which inevitably reduces the safety factor on the sample hose. Research is needed into the ability of these hoses to withstand current and likely air pressures. Better hoses are obviously required.

This research should extend to the possibility for safer alternative sample collection and air discharge methods.

Whipchecks

The external method of restraining hoses with two ended stocking type whipchecks is preferred. Even more preferred is to extend the stocking over the entire hose length to ensure safety in the event of a mid hose failure. Internal whipchecks need more design following more research on the forces involved in hose failures at high pressures.

Ergonomics of Lifting and Associated with Platforms and Walkways

Sample bags present problems with the weight of sample and the frequency that personnel have to lift and carry them during a regular shift. Core trays also present problems with the variety of lengths, number of slots, external dimensions, flexibility, sharp edges and loaded weight. The industry would benefit from rationalisation of these essential products.

During the sub-committee proceedings attention was drawn to problems existing with some present Australian Standards with respect to walkways, platforms, winches and ropes. More research is obviously needed in these areas.

Freedom of Design and Risk Assessment

Throughout the proceedings of this sub-committee emphasis has been placed on avoiding being too specific on the recommendations. It was considered that there should be freedom, particularly for manufactures, to present solutions to design problems in as varied a way as possible in order for the best solution to be not stifled.

This of course requires the designer to follow the requirements of Part 6 of the Regulations in identifying hazards, assessing risks and reducing exposure to the risks. This process will assist the designer in promoting the best and safest design over those designs less so.

Long Term Effects

The long-term effects of some activities can be just as dramatic on any worker's health as short-term trauma. Because a worker does not suffer immediately obvious effects due to dust inhalation or to noise exposure, does not mean efforts to reduce the exposure to these problems should occur.

A Final Word On Manufacturers

It is important to recognise that no input has been received from other than manufacturers in West Australia. There are many manufacturers whose products are in common use within the industry who have not had the opportunity to comment on the "hazards and recommendations" of this sub-committee. Consequently, any purchaser of their products would be well advised to acquaint the other manufacturers with these recommendations in the specifications for drilling equipment prior to purchase.

APPENDIX C1

DEPARTMENT OF MINERALS AND ENERGY
WESTERN AUSTRALIA
Safety Bulletin

No: 31
Date: 17/09/97
Subject: ACCIDENT AND INCIDENT PERFORMANCE IN THE DRILLING INDUSTRY

Details:
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 join. 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 drillers 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 offsiders 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 offsiders 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.

J M Torlach
STATE MINING ENGINEER
17 September 1997

APPENDIX C2

MINES OCCUPATIONAL SAFETY AND HEALTH ADVISORY BOARD (MOSHAB)

PREVENTION OF MINING FATALITIES TASK FORCE

DRILLING HAZARDS SUB-COMMITTEE

MEETINGS FOR PRESENTATION OF INTERIM RECOMMENDATIONS FOR INDUSTRY

DATES: 17TH AND 18TH NOVEMBER 1998
TIMES: 1:00 PM (Both Meetings)

VENUE 17TH NOVEMBER:
ADVANCED TECHNOLOGY CENTRE
120 ROYAL STREET EAST PERTH
To be attended by Australian Drilling Industry Association affiliated members only.

VENUE 18TH NOVEMBER
DEPARTMENT OF MINERALS AND ENERGY THEATRETTE
9TH FLOOR MINERALS HOUSE
100 PLAIN STREET EAST PERTH
For the attendance of:
Drill rig manufacturers and suppliers
Drilling contractors
Mining and exploration companies

COPIES OF RECOMMENDATIONS ARE AVAILABLE FROM:

DEPARTMENT OF MINERALS AND ENERGY WA

Mr John McGee Ph: 9222 3538 EMAIL: j.mcgee@dme.wa.gov.au
Mr Brett Boneham Ph: 9021 9428 EMAIL: b.boneham@dme.wa.gov.au

AUSTRALIAN DRILLING INDUSTRY ASSOCIATION

Mr David Stevens Ph: 9497 1031 EMAIL: davids@ausdrill.com.au

Comments on recommendations should be submitted prior to the 10th November 1998 and to the attention of:
Mr John McGee
C/o Department of Minerals and Energy WA
100 Plain Street
East Perth WA
Email: j.mcgee@dme.wa.gov.au