



**Trade &
Investment**
Mine Safety

Guideline

MDG 1030

Guideline for raiseboring operations

Produced by NSW Mine Safety

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Alternatively, phone (02) 4931 6666.

Foreword

The NSW Trade & Investment document MDG 1030 TR – *Technical Reference Material for raiseboring operations* is attached to this guideline. It provides supporting reference material.

This is a published guideline. Further information on the status of a published guideline in the range of Work Health and Safety (WHS) instruments is available through the Department of Mineral Resources Legislation Update Number 2/2001 which is appended to this guideline.

The range of instruments include:

- Acts of Parliament
- Regulations made under the Act
- Conditions of Exemption or approval (coal mines)
- Standards (AS, ISO, IEC)
- Approved industry Codes of Practice (under the *Work Health & Safety Act 2011*)
- Applied Codes, Applied Guidelines or Standards
- Published guidelines
- Guidance notes
- Technical reference documents
- Safety Alerts and Bulletins

The principles stated in this document are intended as general guidelines only for the assistance of owners and managers in devising safety standards for the working of mines. Owners and managers should rely upon their own advice, skills and experience in applying safety standards to be observed in individual workplaces.

The state of NSW and its officers or agents including individual authors or editors will not be held liable for any loss or damage whatsoever (including liability for negligence and consequential losses) suffered by any person acting in reliance or purported reliance upon this guideline.

This second edition of MDG1030 *Guideline for raiseboring operations*, was distributed to industry for consultation and comment through a representative working group. The input from the working group is appreciated.

NSW Trade & Investment has a review time set for each guideline that it publishes. This can be brought forward if required. Input and comment from industry representatives would be much appreciated. The feedback sheet at the end of this document can be used to provide input and comment.



Rob Regan
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MINE SAFETY OPERATIONS BRANCH
NSW TRADE & INVESTMENT

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1. INTRODUCTION

1.1 PURPOSE AND SCOPE

This guideline is intended to assist mine managers and contractors in the implementation of safe systems of work during the raiseboring of shafts, raises and service holes of any diameter and in any location or configuration in both metalliferous and coal mines.

The scope of this guideline includes the initial planning and design of the project as well as the actual operational aspects of raiseboring.

Where raiseboring projects are subject to competitive tendering to specialist providers, this guideline provides mine managers with an opportunity to base pre-selection of tenderers on a demonstrated understanding of and commitment to addressing those hazards identified in this guideline.

Note that:

- Adherence to guidelines does not in itself assure compliance with the general duty of care.
- Mine operators deviating from guidelines should document a risk assessment supporting the alternative arrangements.

2. REFERENCES

1.2 LEGISLATION

It is imperative that relevant legislation is researched, understood and implemented to ensure compliance.

No specific references are listed here as new NSW mining legislation is imminent but not yet enacted.

NSW Department of Mineral Resources Publications

- MDG 15 *Guideline for mobile and transportable equipment in mines*
- MDG 1010 *Minerals Industry Safety & Health Risk Management guideline*
- Minerals Industry Safety Handbook
- Mine Safety Management Plan Workbook
- Safety Alert SA11-01 *Water inrush from raisebore hole*

1.3 STANDARDS

- AS 4360 - Risk management
- AS 4133.3.4 – 1993 Methods for testing rocks for engineering purposes – Rock swelling and slake durability tests – Determination of the slake durability index of rock samples
- AS 4133.4.1 – 1993 Methods for testing rocks for engineering purposes – Rock strength tests – Determination of point load strength index

- AS 4133.4.2 – 1993 Methods for testing rocks for engineering purposes – Rock strength tests – Determination of uniaxial compressive tests

1.4 OTHER REFERENCES

- T.R.Stacey, SRK, N.D.Harte, Shaft Sinkers (Pty) Ltd – *Deep Level Raise Boring – Prediction of Rock Problems*. ISRM International Symposium, 1989
- A.McCracken, T.R.Stacey – *Geotechnical risk assessment for large diameter raisebored shafts*. Trans. Inst. Min. Met. Sect. A, 98, September December 1989
- Anderson K. *Geotechnical Assessment Guide for Raise Boring Site Selection*. Australian Raise Drilling Pty Ltd (unpublished)
- *Raise Boring Index Testing*. In Raise Bore Manager, Tamrock, Finland
- *The Raise Boring Handbook – Second edition 1997 – Atlas Copco Robins*
- *The safe work practice of changing out a raisebore reaming head underground* - Amalg Resources, Eloise Copper Mine – 2002 finalists – Minerals Council of Australia Innovation Awards.
- *High Grade Uranium Mining at McArthur River, Saskatchewan, Canada* – D. Beattie and T. Davis: AusIMM 8th Underground Operators' Conference July 2002
- *Stability of Raisebored Shafts – The Limitations of the McCracken & Stacey Raisebore Risk Assessment Method*. AMC Consultants December 2006
- W.A.Peck, B.Coombes, M.F.Lee. *Fine-Tuning Raise Bore Stability Assessments and Risk*.
- 11th AusIMM Underground Operators' Conference Pub. 2011

3. RAISEBORING MANAGEMENT SYSTEM

3.1 GENERAL

Management systems for raiseboring should be integrated with the Mine Safety Management System (MSMS) and be based on a risk management approach to safety. Users of this guideline may refer to MDG 1010 *Minerals Industry Safety & Health Risk Management guideline* for more information on this approach.

Systems and procedures for each of the design, management and operational steps identified in this guideline should, where appropriate, be developed in consultation with contractors, employees and their representatives.

The technical reference document appended to this guideline identifies hazards and possible controls. These should be considered when developing hazard controls and safe systems of work for raiseboring projects.

The contents of this guideline are structured to meet the requirements of contracted raiseborer services. Should a mine provide and operate raiseborers in-house, then any risks identified for contractors in the guideline should be included in the development of the mine's own MSMS.

Procedures for monitoring and evaluating the entire raiseboring process should be developed as an initial part of developing systems and procedures. No system/procedure is complete without a monitoring, evaluation and review component.

3.2 RECORD KEEPING AND DOCUMENTATION

The records and documentation of the design, planning, contract development (if applicable) and operation of a raiseborer should be integrated with the MSMS document control system. Accurate records should be kept of all stages of the raiseboring project, from the design stage to commissioning. Particular documents that can be considered may include:

- documented risk assessments associated with the mine planning/hole design, geotechnical assessment, groundwater, gas, provision of operational services, site mobilisation, pilot hole drilling, rod handling, reamer assembly/attachment, reamer collaring, cuttings removal, cutter inspections/changes, removal of reamers and demobilisation
- design parameters and specifications of equipment
- Safe Work Procedures for all high risk activities
- records of nominated responsibilities
- records of relevant geological mapping, drill logs and any resultant interpretation
- records of any actual water or gas ingress in the planned hole location or area of influence
- testing and maintenance of equipment including mobile equipment, the raiseborer, power packs and compressors, drill strings, raiseborer heads and cutters, lifting gear and ancillary equipment
- drilling and reaming reports
- records of training

- records of workplace inspections/audits
- records of hazard reporting and follow up

3.3 TRAINING

The Mine Safety Management System should include a training plan that ensures all employees are trained and competent to perform the tasks required of them. Training should include a documented training assessment. This may be a component of Safe Work Procedure competency assessment.

Particular attention should be given to ensuring that all people working on raiseboring projects are made aware of the correct use and limitations of all equipment they use.

Legislation provides the compliance requirements and Mine Safety Management System development options for mine operators and contractors should a contractor(s) be engaged for a raiseboring project.

Training and competency assessments should be recorded on personnel files.

3.4 MONITORING, SYSTEMS AUDIT AND REVIEW

The raiseboring process, from design to commissioning, should include a monitoring and review process to ensure all required procedures and standards are being complied with. This auditing and review should be part of the continuous improvement process under the Mine Safety Management System. This includes action to:

- monitor record keeping
- audit procedural compliance
- audit implementation of remedial action from hazard identification
- analyse results, both routinely and after special occurrences or problems
- feed outcomes from analysis back into future planning and operations
- integrate the monitoring and review of raiseboring into the Mine Safety Management System review and continuous improvement process.

3.5 RISK IDENTIFICATION AND ASSESSMENT

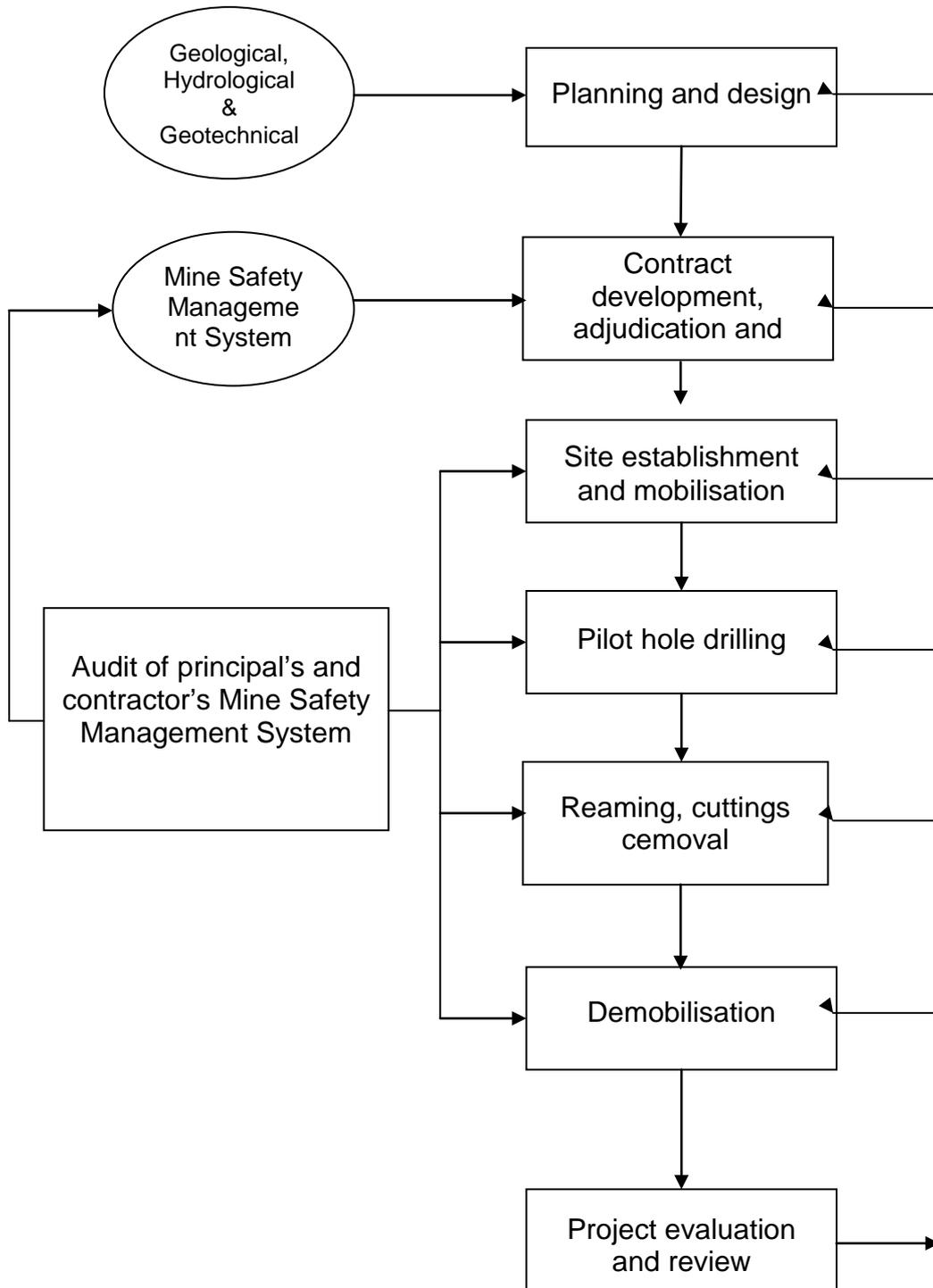
The following section identifies significant hazards associated with the raiseboring process and outlines some of the controls used in the industry to address them.

These lists are not exhaustive. There may be other hazards, including site specific hazards, which must be identified and controlled.

The *Technical Reference Material for Raiseboring Operations - MDG 1030 TR* is attached to this guideline. It provides supporting reference material and tables the key system components, issues to be considered and possible controls.

For more information on how to conduct a risk assessment refer to MDG 1010 *Minerals Industry Safety & Health Risk Management guideline*.

The raiseboring process



4. RAISEBORING OPERATIONS SYSTEM – ELEMENTS AND CONSIDERATIONS

4.1 PLANNING AND DESIGN

Required outcomes

A raisebore hole design that meets the design purpose for the duration of the planned life of the hole and incorporates consideration of hole location, length, inclination and diameter, ground conditions, water and gas occurrences, ventilation and drillability to achieve a stable excavation.

Main risks

- hole fails as a result of inadequate determination and review of geological, hydrological and geotechnical information
- geological, hydrological or geotechnical data is not obtained from, and does not accurately represent, the location of the planned raisebored hole
- unplanned ingress of water or gas, poor ground and/or inadequate provision of services
- pre-mature cutter/drill string failure due to incorrect estimation of the drillability or unpredicted failure of the rock mass
- equipment not fit for purpose. e.g. incorrect selection/match of raisedrill machine, rods, stabiliser, head size/configuration
- cutters fail due to adverse hole geometry (diameter, length, direction and inclination) contributing to increased wear rate or stress
- unplanned project delays (due to operational, technical and/or health and safety issues) that can transpire into delays to the work program and unsafe work practices in an attempt to overcome them
- non-compliant ventilation conditions following break through caused by unexpected air flows
- unplanned breakthrough into existing workings
- unpredicted methane emission in coal mines following reduced mine ventilation pressure on hole breakthrough. There is potentially increased risk if the raisebored hole is a ventilation shaft to surface.
- risks associated with the planned removal of the reamer from the bottom or top of the hole

Main risk considerations

- determine that predicted ground conditions parameters are established and defined by industry standards
- ensure that the evaluation of geological, hydrological and geotechnical parameters are conducted by a competent person
- ensure that the conditions of the rock mass and rock properties are known prior to 'sign off' on hole design

- where design options allow, risks associated with non-vertical, longer or larger diameter holes are minimised
- consult with contractors and raiseborer operators in the design and standardisation of raisebore chambers and breakthrough positions
- avoid designing holes in known poor ground
- avoid unplanned hole breakthroughs due to inadequate hole design, checking for existing intermediate excavations or providing insufficient clearance from intermediate excavations to accommodate potential hole deviation
- wherever possible, provision should be made in the design for, reamer removal from the top of the completed raisebore hole. However, considerations must include the size and weight of the reamer when designing lifting arrangements
- ensure raiseborer chamber design provides adequate space to position equipment and allows pedestrian access for machine operation and maintenance
- ensure adequate rod storage and handling facilities are included in the project design
- ensure adequate drainage is provided at the break through point and in the raiseborer chamber
- allow for typical/contractual hole deviations
- select and configure cutters to reflect an assessment of drillability, geological structures and discontinuity
- avoid non-compliance of safe work procedures because the Mine Safety Management Plan is not effectively managed. 'Shortcuts' may be taken to eliminate or minimise unplanned project delays
- develop TARPs (trigger action response plans) for major identified hazards and remedial control e.g. hole deviation contingencies, full and real-time reconciliation of chippings generated versus removed, water ingress, hole scaling etc.
- avoid unplanned events caused by inadequate provision of project services (voice and data communication, auxiliary ventilation, purpose-designed rigging points, purpose designed civil works, electrical power, lighting, compressed air, drainage, pumping, cuttings handling/disposal)
- ensure ventilation plans and ventilation infrastructure are adequately designed and prepared prior to break through
- monitor methane occurrences in coal mines throughout the pilot hole drilling and reaming phases of the project
- provide forced in-hole ventilation to disperse methane, if present or expected
- include consideration of the potential for frictional ignition of coal dust in control measures
- ensure approved design specifications (including conservative factors of safety) for lifting points and civil works are included in the project scope
- test installed lifting points
- review the ground support pattern after the reamer head excavation is mined including brow support of the post-reamed area

4.2 CONTRACT DEVELOPMENT

Required outcomes

A negotiated contract that is accurately scoped, includes systems that have identified and risk-ranked potential hazards with appropriate actions and TARPs to control them.

A contract that is fully scoped and completed before project commencement, and is auditable throughout the contract term. A contract that minimises the likelihood of surprises, which may adversely affect the safety performance of all affected parties.

A contract that allows for risk reducing incentives and penalties, standing time provision, defined contract advance rate(s) and a formal process to vary.

Main risks

- the tender invitation scope does not adequately identify hazards. Some hazard control provisions have not been made in the pricing and construction schedule and, therefore, possibly result in risk taking
- an inadequate and/or non-compliant Mine Safety Management System and/or contractor management system
- geological, hydrological and geotechnical information is not available at the time of tendering, or is incomplete or inaccurate
- the contractor has not developed adequate systems to manage safety and health
- the principal has not developed adequate systems to manage safety and health
- the project schedule does not include provision for establishing and managing safety and health systems
- contractual obligations negatively affect health and safety issues
- tendered advance rates are not achieved
- undue business pressure on the contractor due to unforeseen circumstances or circumstances beyond the control of the contractor
- effective systems of communication are not detailed in the contract scope
- the contractor fails to provide equipment that meets recognised standards.
- the contract scope does not specify removal of the reamer head from the top of the hole when it is practicable to do so

Main risk considerations

- the contract tender scope is prepared before commencement of contract negotiations
- the contract scope addresses all identified hazards associated with the project
- the tender document addresses all risks identified in the contract scope
- assessment of contractors' safety and health systems are included in a formal tender evaluation
- a contractor's Safety Management System is approved by the general manager or the contractor agrees to follow the mine's Mine Safety Management System
- comprehensive safety and health systems are developed and communicated prior to project commencement

- tender award process to include pre-tender site inspection(s) and discussions
- formal auditing of relevant contractor's and principal's safety and health systems are included in the conditions of contract along with provision for task observations
- scope to include provision for QA/ QC auditing of contractor's plant and equipment against recognised standards
- include specific/standard mine designs for raiseborer chambers with the tender invitation documentation
- establish a detailed base line construction schedule prior to commencement
- scope to specify shift monitoring and reporting to the project manager/client
- contract conditions to include formal processes for variation and extension of time (EOT) e.g. raiseboring rates, extraneous circumstances. Contractual penalties and incentives, if applied, to be based on safety and quality rather than time
- scope includes contract responsibilities for all critical activities e.g. consider bogging operators to be supervised and controlled by the raisebore operator

4.3 SITE ESTABLISHMENT AND MOBILISATION

Required outcomes

A raiseborer project in which the provision and application of necessary site works and infrastructure does not increase the risk of injury to personnel or adversely impact on the effectiveness or efficiency of the project.

Main risks

- the design, planning, mining and support of excavations and the equipping of raiseborer chambers and/or breakthrough positions is inadequate
- the raiseborer chamber is not designed, configured or equipped for safe operation and maintenance of the installed equipment
- lifting points and associated equipment do not meet engineering design standards. Installed ground support is not to be used as rigging points
- civil works are not designed or constructed to industry standards e.g. concrete foundation pads are not bonded to solid rock
- the specification or maintenance condition of installed equipment is not fit for purpose
- risks associated with the transportation of equipment and ancillary gear are not adequately identified or addressed
- the delivery sequence of equipment to the raiseborer site/chamber site has not been adequately planned

Main risk considerations

- confirm no misfires before commencement of civil work
- before being used at the mine, ensure competent people conduct mechanical and electrical inspections of equipment and ancillary gear to establish that they are fit for purpose and meet an appropriate standard
- ensure equipment is subjected to an appropriate and effective maintenance plan

- communicate raiseboring machine and ancillary equipment specifications to relevant engineers prior to the design of associated mine excavations power and other installed services, such as flushing water and water drainage
- deliver equipment to the raiseborer site in a planned sequence to minimise risks associated with rehandling, inappropriate storage and work area constraints
- document and communicate risk assessments and resultant controls identified during transportation of equipment and ancillary gear to the worksite(s) before work begins
- ensure lifting points required during equipment transportation and installation are designed and installed to demonstrable engineering standards and mine site geotechnical input
- consider installation of low voltage lighting
- ensure rod handling system is fit for purpose for rod specifications

4.4 PILOT HOLE DRILLING

Required outcomes

A pilot hole that breaks through on schedule within acceptable tolerance of the planned location without damage to any installed services. There should be no risk to people from falls of ground at, or adjacent to, the break through position or disruption to the ventilation circuit.

Main risks

- pilot hole misses target – potential break through into other workings and/or unplanned project delays
- pilot hole breaks through into unplanned location due to excessive hole misalignment, inadequate planning or excessive deviation
- injury from rod handling in raiseborer chamber and/or rod storage location
- injury during management of cuttings at top of the pilot hole
- uncontrolled releases of energy while flushing hole
- loss of circulation of flushing water/medium while pilot drilling
- environmental contamination
- rock falls or bedding separation (particularly coal mines) on break through
- damage to installed services at break through location
- significant inflow of groundwater and/or drilling fluids on break through
- interception of methane gas in coal mines or in metalliferous mines
- adverse ventilation through a completed pilot hole is not considered in the pre-pilot hole drilling risk assessment
- high pressure fluid injection injury potential

Main risk considerations

- ensure (and audit) competence of raisebore operators
- develop an environmental response plan before drilling starts
- define personnel 'no-go zones' and associated procedures

- before the pilot hole is collared, and during the drilling of the first two stabilisers, the dip angle and bearing of the hole should be checked by a competent surveyor
- provide well-designed cuttings collection and disposal facilities to minimise the risks of bogging the rod string and injury from manual handling
- provide protection to people from flying debris during hole flushing
- minimise the risk of rod string failure by use of crack detection procedures and certification prior to site mobilisation
- ensure deviations in directional drilling fall within agreed tolerances and rates of change
- limit excessive hole deviations while directionally drilling to reduce raisebore rod stresses during reaming
- ensure a managed and effective rod rotation system between projects
- provide a mechanism for measuring flushing water return flow rate and documented TARPs for loss of flushing water/medium
- ensure operating procedures include timely and effective barricading of the break through position to prevent injury from rockfalls on break through
- ensure effective and ongoing communication with all potentially affected parties as to the status of the pilot hole e.g. issuing timely holing warning notices
- in coal mines, assess the risk of poor roof conditions in the proximity of the break through position. Bedding separation may be caused by ingress of groundwater from the pilot hole or release of accumulated gas
- ensure a ground water control plan is in place before break through
- ensure that any installed services adjacent to, or at, the planned breakthrough position are either removed or effectively isolated

4.5 REAMING AND CUTTINGS REMOVAL

Required outcomes

Reaming and cuttings removal operations that do not expose people to at-risk situations.

Main risks

- crush injury or manual handling injury during reamer assembly and attachment to drill string
- inaccurate monitoring and reconciliation of chippings volume being produced versus chippings volume removed
- chippings monitoring and reconciliation is not undertaken in real time
- operator fatigue
- dust contamination of mine ventilating air during reaming
- water or 'mud' (cuttings) inrush
- 'hang up' and subsequent sudden failure of dry or wet cuttings
- brow failure while people are working in the vicinity of the brow
- interception of methane gas in coal or metalliferous mines

- spontaneous combustion in any coal seam or coal bearing material that is intersected by the raisebored hole
- exposure to injury from falling rocks or debris while inspecting or changing raiseborer head cutters at the bottom of a partially reamed hole
- catastrophic drill rod or reamer stem failure resulting in rods and/or head falling to the bottom of the hole or becoming jammed in the hole in an inaccessible location.
- cuttings are removed from the active raisebored hole and dumped and/or stored in unsafe situations.
- ensure correct selection of bailing medium to suit geological/hydrological conditions.
- ventilation reversals and/or short circuiting
- consider the risk of a power cut

Main risk considerations

- mine the access to the bottom of the raisebored hole in such a way that the hole is offset to the access drive to reduce the risk of inrush or reamer/rod failure being directed along the access drive. Incorporation of a right angled corner or long radius curve near the hole position may be considered
- understand and reconcile planned volumes versus bulked volumes versus actual bucket load volumes of chippings
- develop and implement an effective fatigue management plan
- develop Safe Work Procedures for cuttings removal through formal hazard identification, risk assessment and implementation of effective control of hazards
- provide effective dust suppression
- include elimination of hazards associated with build up of compacted cuttings in the raisebored hole in Safe Work Procedures for cuttings removal

- ensure direct and effective real time communication between the raisebore machine operator/supervisor and bogging operator/supervisor
- conduct a risk assessment and implement controls for planned short and long term storage or dumping locations for raiseborer cuttings. Use of vertical storage and shaft hoisting to be considered as potential major hazards.
- conduct a risk assessment and implement controls for the transportation of cuttings
- particular attention to be given to geological, hydrological and geotechnical assessment of ground conditions at and adjacent to the planned breakthrough position of the pilot hole. Install ground support to meet both short and long term requirements.
- develop and implement Safe Work Procedures, based on formal risk assessments, which control the risks associated with inspecting or changing reamer cutters at the bottom of a partially reamed hole
- implement procedures for cutter inspection and/or replacement or reamer removal that do not position persons directly beneath an open hole
- consider the use of a physical shield or barrier to provide protection against ricochet/falling rocks when inspecting cutters or removing a raiseborer head
- implement procedures which control any potential ingress of methane gas
- minimise risk of rod or reamer stem failure by addressing the factors that may contribute to a failure
- ensure correct hydraulic pressure settings and adherence to planned advance rates
- operate a system to detect imminent rod failure while reaming such as utilising internal pressure loading of the drill string and measuring pressure loss to indicate potential failures
- should a rod string or reamer stem fail, implement controls which minimise or eliminate exposure to risks from ricochet/ falling rocks from the raisebored hole during reamer/rod recovery

4.6 DEMOBILISATION

Required outcomes

Leaving a safe and secure site after safe removal of the reamer and all associated equipment and infrastructure from a completed raisebored hole.

Main risks

- equipment or material falling down a completed hole
- exposure to falling objects during reamer removal while working adjacent to the bottom of a completed hole
- provision of personnel protection devices and/or equipment that does not meet Australian Standard or industry design standards
- hazards associated with slinging, rigging and foundation stability during reamer removal at the top of a hole
- in coal mines provide effective controls for potential spontaneous combustion in

intersected coal seams or coaly material

- in coal mines the potential for contraband or flame to enter gaseous atmospheres on reamer breakthrough to surface
- personnel falling into an open hole

Main risk considerations

- prior to break through identify potential hazards, conduct a risk assessment, and implement controls and procedures that minimise the risk of equipment or material falling down the hole
- if working adjacent to the bottom of a completed hole consider the use of a physical barrier. The decision to utilise a particular design/configuration of barrier should include consideration of the risk of hole deterioration and the worst case dynamic loading on the barrier.
- if removing a reamer at the bottom of the hole, consider the use of remote reamer breakout equipment or the use of long cutting lances to remove the reamer. This may be particularly applicable when the hole has become unstable and there is a risk of material falling from within or ricocheting from the hole.
- the reaming of the final section of the hole should be designed and carried out to minimise the risk of failure of the foundations or rock cap on which the raiseborer machine is mounted
- only competent people should carry out slinging and rigging work using certified equipment and specifically designed anchor points
- sudden airflow into a coal mine on reamer breakthrough to surface should be simulated and appropriate controls and procedures implemented to provide a managed airflow, site security and minimal risk of contraband entering the mine
- develop and implement 'open hole' fall protection controls and procedures
- check the security of loads and associated loose debris when transporting equipment from site
- set up the area at the base of the hole and associated development for the post-reaming intended use and provide appropriate barriers to prevent access
- complete a formal documented handover to the client/mine operations

FEEDBACK SHEET

Your comment on this guideline will be very helpful in reviewing and improving the document.

Please copy and complete the feedback sheet and return it to:

Area Manager – Central West

Mine Safety Operations
NSW Trade & Investment
Locked Bag 21
Orange NSW 2800
Fax: (02) 63605363

How did you use, or intend to use, this guideline?

What do you find most useful about the guideline?

What do you find least useful?

Do you have any suggested changes to the guideline?

Thank you for completing and returning this feedback sheet



Trade &
Investment
Mine Safety

MDG 1030TR
2nd edition

**Technical Reference
Material for
raiseboring operations**

PREFACE

The contents of this report may be used as fundamental input into any risk assessment process associated with the planning, design, contract development, site establishment and completion of a raiseboring project. As such, a copy should be provided to each member of a risk assessment team to assist in developing safety and health controls tailored to a mine's particular circumstances.

The guidance material and possible controls for known hazards contained in this guideline may also be useful reference for supervisory personnel and operators before and throughout a raiseboring project.

The material covers the major elements of a raiseboring project as identified by an industry working group.

The process of raiseboring from the design and planning stage to site demobilisation is depicted in a flowchart in MDG 1030 – *Guideline for raiseboring operations*.

The raiseboring process consists of the following project elements:

1. **Planning and design** – consideration of relevant information to enable timely and effective project planning and design and control of identified hazards.
2. **Contract development** – establishing an agreed contract scope that identifies and includes major hazards and controls that may form part of the tender evaluation process and compliance auditing during the execution of the project.
3. **Site establishment and mobilisation** – considerations during the mining, equipping and provision of services for the total raiseboring project.
4. **Pilot hole drilling** – safely establishing the pilot hole to planned specifications to enable reamer attachment.
5. **Reaming and cuttings removal** – reaming the raisebored hole to final design diameter, inspection and replacement of cutters and the reaming head and the safe removal, transport and disposal of cuttings.
6. **Demobilisation** – considerations during the removal and transportation of services and equipment from the project site.

It is particularly important that risk assessments and the development of hazard controls include a review of all elements of the project as identified by MDG 1030 and the additional material and references contained in this Technical Reference.

The principle objectives of this document are to identify and provide:

- examples of good industry practice
- matters that should be considered in developing safe systems of work for raiseboring operations; and
- identification of various possible technical, operational and management controls.

Matters to be considered with each of the raiseboring project elements are identified, and guidance material is provided, from page 7 onwards in this document.

WORKING GROUP MEMBERS

In 2003 the NSW Chief Inspector of Mines set up a working group to develop this guidance material. Their contribution is appreciated and acknowledged with thanks.

The working group members were:

Brett Amos Andy Cullum	Area Manager, Mechanised Boring – Australia, Baker Hughes Project Manager, Northparkes Mines, Henry Walker Eltin Contracting Pty Ltd
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GUIDANCE MATERIAL FOR RAISEBORING OPERATIONS

PROJECT ELEMENTS OF RAISEBORING

ELEMENT: PLANNING AND DESIGN

The planning and design of a raisebore hole should incorporate consideration of hole location, length, inclination and diameter, ground conditions, water and gas occurrences, ventilation and drillability. The objective is to achieve a stable excavation that meets the design purpose for the duration of its planned life. The scheduling of the project should also take into consideration these factors to ensure that activity sequencing and timing does not compromise safety.

Activity	Issues to be considered	Notes and possible controls
Scheduling	Delayed design and inaccurate scheduling may result in compromising the design resulting in angled holes, when vertical hole design may otherwise have been possible. Angled holes increase stress on drill string and increase the risks associated with reamer collaring and head removal.	Early identification of the need for raisebored holes in long term and medium term mine planning schedules. These should incorporate all access and associated development for the project. Integrate hole design with general mine development scheduling to avoid modifications having to be made from a vertical hole to an inclined hole design due to failure to meet development schedule(s). Schedules should be based on realistic development rates that take into consideration hole location, geological and geotechnical conditions, ventilation, groundwater, gas occurrences etc Ventilation design and provision of adequate heat and dust control to both the target and collar (if collared underground) locations should be included in the project design.
Scheduling	Metalliferous mines - unplanned significant changes to ventilation airflow.	Ventilation modelling and simulation during the design phase should ensure that vent control devices are ready and in place prior to breakthrough. Prior to breakthrough, procedures should be in place and communication established with supervisors and all crews. Suggested controls are: <ul style="list-style-type: none"> ▪ Prior planning and ventilation simulation. ▪ Breakthrough procedures to include anticipated ventilation changes.
Scheduling	Geotechnical and hydrological assessment and availability of results are made available too late to be incorporated into potential design changes. This may lead to reduced confidence in information by a contractor when preparing the tender bid.	Allow sufficient time for completing geotechnical and hydrological evaluations within the project plan. Should the evaluation of information from geotechnical drilling and /or mapping be included in the project design, then allow adequate time for the design to be modified if necessary, and for quality information to be made available to tenderers. This will increase confidence in assessments of ground conditions. This could then prevent last minute design changes and inadequate preparation that could place the project at risk.
Design	Planned design may not be practical	Consider all the design related hazards identified in this document and ensure suggested controls are considered in the design of the raisebored hole and associated development. Consideration and, if practical to do so, preference should be given to the removal of the raiseborer

Activity	Issues to be considered	Notes and possible controls
		<p>head from the top of the hole on completion. Top of hole removal may require specific design and installation of lifting equipment. The size and weight of large reamers may prohibit top of hole removal. Ensure that the raiseborer chamber is designed to provide adequate space to position equipment and allows pedestrian access for machine operation and maintenance.</p>
<p>Design</p>	<p>Ventilation design considerations</p> <p>Coal mines – risk of major changes to ventilation circuits and the potential for methane emissions during pilot hole drilling and reaming.</p> <p>A particular risk may exist at the completion of reaming.</p> <p>Methane may be generated from coal seams, coal strata and possibly porous sandstone.</p>	<p>Consideration should be given in the design phase of the project to the provision of controls for changes in the mine ventilation system and potential methane emissions and spontaneous combustion during and after the raiseboring operation.</p> <p>The majority of shafts drilled in coal mines are usually intended to be used as future exhaust ventilation shafts and are therefore located in the return airway. Consequently, any dust and gas that may be generated while reaming is drawn out of the mine via the return airways. This also means that the shaft and pilot hole will be downcasting past the drill pipe while reaming.</p> <p>Consideration should be given to the direction of air flow during pilot hole drilling and reaming and the potential accumulation and measurement of methane at both the top and bottom of the hole. The same consideration applies while the machine is shut down for any reason. Methane is lighter than air.</p> <p>Upon breakthrough at the completion of reaming, short-circuiting or reversal of the mine’s return airway system could occur. Therefore, prior to breakthrough, a ventilation plan must be prepared and be ready to be put in place. This may consist of additional brattices, overpasses and vent walls, much of which can be constructed prior to breakthrough. However, this construction must be planned, scheduled and undertaken so that free access to the bottom of the shaft is maintained for mucking and stowage of cuttings and to ensure that an adequate ventilation flow past the bottom of the shaft remains. Access for inspection must also be provided.</p> <p>Possible controls to avoid disruption to mine operations due to a changed ventilation circuit on reamer breakthrough are:</p> <ul style="list-style-type: none"> • Prepare plans and erect ventilation infrastructure prior to breakthrough. • Consider access to the shaft bottom area and stowage areas while reaming. <p>There is a potential for methane to accumulate at the cutter head. The hazards of this can be mitigated somewhat by considering the following:</p> <ul style="list-style-type: none"> • Drilling of the pilot hole will allow drainage of methane from the local strata. During the drilling phase, any such methane can be monitored at the hole collar and the potential for gas accumulation during reaming can be assessed. Consider the use of a continuous gas monitor(s) • While reaming, the mine ventilation pressure difference could ensure a small but significant airflow down past the rods in the pilot hole, resulting in movement of air out of the shaft and into the mine return airways. • This, combined with the air turbulence created by the cutting action of the head and the falling cuttings, should mean that any gas generated at the face will be quickly dispersed into the

Activity	Issues to be considered	Notes and possible controls
	<p>In coal mines, ignition of methane or coal dust through frictional energy from cutter head picks and energy induced into, and retained by, silica particles within the rock mass.</p>	<p>surrounding air and drawn down the shaft.</p> <ul style="list-style-type: none"> • This airflow can then be monitored for the presence of methane. • If methane is detected or the hazard is assessed as an unacceptable risk, a sample of the air at the cutter head could be drawn up through the centre of the drill pipes. • In the event of gas accumulation occurring, then compressed air should be forced down through the drill pipe to flush any accumulated methane from the shaft. • Given the above, possible controls for dealing with methane accumulation are: <ul style="list-style-type: none"> ▪ Gas monitoring of pilot hole to assess the potential hazard. ▪ Maintain shaft-through ventilation, with as strong a ventilation pressure difference as possible. ▪ Regular gas monitoring at top and bottom during reaming. <p>In the event of hazardous levels of gas being detected, then consider:</p> <ul style="list-style-type: none"> • Ceasing reaming and flushing the pilot hole with compressed air through the drill pipe and water down the outside of the pipe. • Sampling gas accumulation at the head through the drill pipes. <p>Control measures for frictional ignition of methane or coal dust may relate to pick design, water flushing and head rotational speed (aimed at limiting input energies to the rock mass)</p>
<p>Design</p>	<p>Geological / geotechnical / hydrological assessment.</p> <p>Inadequate geological, geotechnical or hydrological evaluation creating an increase in the risk of falling ground and/or caving during reaming, during cutter inspections, during head removal or during post raiseboring activities.</p>	<p>Raiseboring operations require accurate and informed knowledge of the conditions of the rock mass and properties of the rock before the raiseborer chamber and associated development is mined or a hole is raisebored.</p> <p>Loss of core from diamond drilling of a pilot hole may result in incorrect interpretation of ground conditions.</p> <p>Drill core quality and recovery can be enhanced by:</p> <ul style="list-style-type: none"> ▪ Locating a diamond drill hole as close as possible to the raisebored hole position to improve confidence in the relevance of gathered information ▪ Appointment of drilling contractors and operators with proven competence. ▪ Use of triple tube coring in overburden and immediately wrapping core. ▪ Paying particular attention to correct handling and orientation of core. ▪ Conducting rigorous and frequent checks on the core barrel, wire line attachments etc. <p>Ground conditions can be assessed during development mapping and diamond drilling. Rock properties and structural features can be determined from a diamond drill core.</p>

Activity	Issues to be considered	Notes and possible controls
		<p>The ground conditions throughout the full length of the hole must be suitable for a freestanding unsupported excavation.</p> <p>Consideration must be given to the provision of suitable controls for rock falls, rock failures, and water inflow from the side wall and face during the lifecycle of the raisebore hole.</p> <p>Exploratory diamonds drill holes in the vicinity of the designed position of the raisebored hole should be grouted prior to pilot hole drilling to reduce the risk of loss of water circulation during pilot hole drilling.</p> <p>The most important factors affecting stability are:</p> <ul style="list-style-type: none"> ▪ structural features (folds, faults, foliation, bedding, discontinuities etc), ▪ mechanical properties of the discontinuities and of the rock fabric (tensile, compressive and shear strength), ▪ stress (in situ and mining induced) and ▪ ground water quantity and quality. <p>The assessed risk level of any raisebore project will depend on the confidence that can be placed in the relevant parameters used to determine assessment results.</p>
Design	<p>Rock quality</p> <p>Inadequate evaluation of rock quality resulting in unplanned penetration rates, excessive cutter wear or rock falls.</p> <p>In soft rock, some materials such as mudstone change their chemistry when exposed to atmosphere and/or water.</p>	<p>Penetration rates are a function of rock mechanical properties, namely: strength, abrasivity and hardness.</p> <p>Strength can be tested and described as tensile (direct method or Brazilian testing), shear (shear box testing) or compressive (uniaxial or point load testing).</p> <p>Abrasivity can be tested in Los Angeles Machine and hardness can be described as raiseboring index or hardness index.</p> <p>Quartz content in the rock fabric may give an indication on rate of cutter wear.</p> <p>The physical structure of such materials may change and become 'putty like' or disintegrate altogether. This change is usually time dependent.</p>
Design	<p>Stability index</p> <p>Inadequate evaluation and /or use of inappropriate or inaccurate stability index.</p> <p>The potential for the intersection of zones of 'running sands' in sandstone.</p>	<p>There are a number of rock mass classification systems that are available to combine geotechnical parameters and excavation stability. For raiseboring purposes the most commonly used is the "Q" system modified by McCracken and Stacey. This system takes into account rock block size (Rock Quality Designation and joint set number), discontinuity shear strength (joint roughness and joint alteration) and active stress (Water Reduction Factor and Stress Reduction Factor). For a raiseboring purpose, the system has been modified by introducing adjustments for orientation of discontinuities, weathering and wall factor.</p> <p>A raisebore stability ratio is dependent on the function of the hole and on its planned life. The stability ratio of 1.3 is usually assigned for ventilation raises and 1.6 for ore passes.</p> <p>If not detected during exploration drilling and effectively managed, uncontrolled inrush of water and sand could occur. Catastrophic hole collapse is likely under these conditions. Control measures can include hole lining or freezing of ground.</p> <p>The potential for running sand should be detected during exploration drilling. However, this may prove</p>

Activity	Issues to be considered	Notes and possible controls
		difficult if the density of drilling mud is greater than the liquified sand.
Design	<p>Determination and management of water occurrence and flows.</p> <p>Inadequate evaluation resulting in unplanned water ingress.</p>	<p>Analyse major structures in the planned path of the hole that may be water bearing. Raiseboring generally precludes the immediate provision of sealing ground where water bearing strata is intersected.</p> <p>Analyse data from filled/unfilled stopes adjacent to path of raise – is the fill wet, dry, saturated and / or stabilised? Measures should be taken to ensure circulation is maintained when a pilot hole is drilled through a filled stope or development void.</p> <p>During drilling a geotechnical drill hole and a pilot hole, ground water conditions should be closely observed, monitored and recorded. Should water be expected or encountered, water quality should be determined and pump tests carried out to determine permeability and the rate of water inflow. Rock samples should be tested for permeability. Continuous monitoring of water inflow to the underground excavations should be carried out.</p> <p>Results from water testing, permeability tests and changes in water inflow should form a basis for analysis of risk and quantity of water inflow during raiseboring.</p> <p>Consider construction of an extended pre-sink if there is unconsolidated water bearing material near the collar of the raise</p> <p>If a wet hole is anticipated, the mine design should include provision for water to be directed and controlled at the bottom of the raisebored hole.</p> <p>Consideration should be given to the provision of adequate water storage to protect major infrastructure such as pumps and electrical installations.</p> <p>Adequate standby pumping capacity should be provided.</p> <p>Consider pressure grouting.</p>
Design	<p>Geological structures.</p> <p>Inadequate evaluation, resulting in potential rock falls.</p>	<p>A major factor affecting the stability of a raisebored hole is its diameter. The face stability can be determined in terms of maximum unsupported span that is a function of the raise bore stability index. During reaming the face is more liable to instability than the sidewall, although during the cutting operation itself the raiseborer head provides a degree of support. The potential for failure wedges should be analyzed in terms of the potential for key block failure, i.e. failure of a particular block that would produce a domino effect and subsequent gravity failures, causing significant damage to the raise wall.</p> <p>Different stability criteria may be considered acceptable for the raise face and raise walls. The raise face is temporary and its failure is likely to affect the raisebore head. The raise walls are permanent and their failure may lead to progressive and catastrophic failure after completion of raiseboring operations.</p> <p>Relaxation of ground during lengthy reaming stoppages may represent a hazard resulting in ground failure. It is preferable to achieve continuity of reaming whenever possible to do so.</p> <p>Failure may be caused by gravity falls or movement of joint determined blocks or wedges, or by displacement by the cutters.</p>
Design	Drillability.	Whenever the head is lowered for cutter inspections or changes, the support at the face is withdrawn.

Activity	Issues to be considered	Notes and possible controls
	<p>Avoid cutter changes by selection based on drillability.</p> <p>Inadequate evaluation resulting in the need for unscheduled cutter inspections / changes.</p>	<p>It is at this time that failures are most likely. Failures from the edge of the face can subsequently undercut the sidewall.</p> <p>If cutter changes are anticipated during the reaming phase, if possible schedule the lowering of the head, inspections and cutter changes when reaming a zone of known good ground conditions. This will reduce the probability of ground failure at the face while the reamer is lowered to the bottom of the hole.</p> <p>An uneven face can create vibrations and unbalanced drill string loading when re-establishing reaming at the face.</p>
<p>Design</p>	<p>Raiseborer chamber.</p> <p>Inadequate support design results in ground instability.</p>	<p>Changes in mining induced stress or long stand up time can result in loosening of rock in the backs or walls of the chamber.</p> <p>Raiseboring chambers are often characterized by a high height to width ratio. With such a ratio it may be difficult to notice any changes in geotechnical conditions. It is also difficult to install ground support once the raiseborer and ancillary equipment is installed. It is recommended that, as a minimum standard, all raisebore chambers are fully supported with mine standard bolts and meshed. In poor or fair ground conditions a competent person should specifically design ground support for each chamber.</p>

ELEMENT: CONTRACT DEVELOPMENT

A raiseborer project contract should be accurately scoped, and include systems that have identified and risk-ranked potential hazards with appropriate actions and Trigger Action Response Plans (TARPs) to control them. A contract should be fully scoped and approved prior to project commencement and allow for consideration of risk reducing incentives and penalties, contract advance rate and a formal contract variation process. The contract should then be written so that safety systems contained within it can be audited throughout the contract term.

A contract should minimise the likelihood of 'surprises' that may adversely affect the safety performance of all parties and confidence in pricing.

Activity	Issues to be considered	Notes and possible controls
Contract Development	Significant operational and contractual matters may be excluded from or not fully explained in the contract scope	Ensure that, as a minimum, a review of the 'Main Risks' tabled in MDG 1030 is conducted during tender invitation scope development to provide tenderers the opportunity to submit a conforming tender that addresses known operational and business risks. Provide opportunities for pre-tender site inspections and discussions in the tender award process.
Contract Development	The design specifications for the hole, civil works and associated development may not have been completed prior to contract tendering. This may reduce the level of confidence for tenderers and increase pricing contingencies.	There is a risk that the principal and / or the contractor may possibly revert to risk taking to recover contract shortfalls The principal could provide background information and a statement of confidence as supporting information in tender invitations. This may enable tenderers to minimise the inclusion of 'contingencies' to provide protection against potential shortfalls.
Contract Development	Quality & scope of geotechnical / hydrological information.	The principal should provide all relevant geotechnical and hydrological information to tenderers. Also, the principal should be prepared to demonstrate consideration of the geotechnical and hydrological risk considerations listed in MDG 1030 as well as any other site-specific hazards.
Contract Development	Safety Management System / Contractor's Safety Management System.	Ensure that appropriate review and 'sign off' as part of the relevant Safety Management System (SMS) meets legislative requirements In particular, consideration should be given to provide documentation in a contract to support the following programs: - <ul style="list-style-type: none"> ▪ Policy ▪ Document control ▪ Hazard identification ▪ Risk assessment ▪ Emergency response planning ▪ Consultation & communication ▪ Job Safety Analysis ▪ Safe Work Procedures

Activity	Issues to be considered	Notes and possible controls
		<ul style="list-style-type: none"> ▪ Hazard reporting ▪ Fitness for work ▪ Fatigue management ▪ Equipment maintenance ▪ Injury / illness reporting ▪ Accident investigation ▪ Environmental monitoring ▪ Health surveillance ▪ Personal Protective Equipment ▪ Contractor management ▪ Training & competency assessment ▪ Audit & program review
Contract Development	Tender prequalification.	<p>Consider a prequalification process initially based on an evaluation of the tenderers' proposed Safety Management System for the project and evidence of health & safety leading indicators from previous projects.</p> <p>Each program can be evaluated and 'scored' to rank each tender. Eliminate tenders that do not meet a predetermined minimum standard which then provides the principal and contractor with auditable safety systems throughout the duration of the project.</p> <p>This prequalification process should not include evaluation of contractors' commercial submission. Evaluation of commercial tenders should only be initiated once contractors have successfully completed the prequalification stage.</p> <p>Consideration should be given to ensuring all relevant risks are identified, and that they are adequately addressed in the successful tender. Reference should be made to hazards identified in MDG 1030 – <i>Guideline for raiseboring operations</i>, and MDG 15 - <i>Guideline for mobile and transportable equipment for use in mines</i>.</p> <p>If not addressed in the tender, ongoing negotiations are recommended to ensure an agreed and documented Safety Management System is in place. The system should include provision for all required safe work method statements to be available prior to project commencement.</p> <p>Relevant sections from the principal's Mine Safety Management System should be made available to tenderers at this stage. Opportunities should then be provided for tenderers to seek clarification and input.</p> <p>During prequalification consider the inclusion of the evaluation of tenderers' equipment utilisation and maintenance history and compliance to established equipment standards.</p>

Activity	Issues to be considered	Notes and possible controls
Contract Development	<p>Tender evaluation.</p> <p>Inadequate assessment of a tenderer's commitment to safe systems of work.</p> <p>Safety Management System audits.</p>	<p>A tender evaluation based on price alone is unlikely to result in a commitment to safety from either the principal or the contractor.</p> <p>Consideration should be given to adopting a tender evaluation process that includes all the relevant criteria that may affect the safety performance and success of the project. A weighted and scored criteria decision making process may be deemed suitable. <i>(for example, ref Kepner Tregoe decision making process)</i></p> <p>The tender evaluation and contract negotiation processes provide the best opportunity to ensure that effective safety systems are planned, documented and meet the relevant legislative requirements. The agreed contract document can then be used to audit the safety system throughout the project. A systematic approach at the tender evaluation and contract development stages may provide an outcome that results in opportunities for additional and ongoing efficiency improvements. Implementing a systematic approach to identifying hazards and implementing controls often achieve this.</p>

ELEMENT: SITE ESTABLISHMENT AND MOBILISATION

Activities associated with the site establishment and mobilisation of a raiseborer project should be systematically reviewed to minimise risk. The necessary site works and infrastructure should be provided so as not to increase the risk of injury to personnel or damage to equipment. When correctly planned and implemented, the outcome can result in a more effective and efficient project.

Activity	Issues to be considered	Notes and possible controls
Site Establishment and Mobilisation	<p>Project commencement is delayed because some equipment is not on site.</p> <p>Project commencement is delayed because some equipment is worn or not fit-for-purpose.</p>	<p>The management of the project should include detailed packing lists and checking mechanisms prior to dispatch of equipment from the previous site or storage facility.</p> <p>Prior to site mobilisation, conduct inspections of equipment for tool tolerances, signs of wear etc and replace or repair substandard items. The top wrench should be considered a high-risk component.</p>
Site Establishment and Mobilisation	The construction of foundations and any other 'civil' works required for the raiseborer must be designed to withstand the worst-case scenarios that may arise during the project.	<p>In designing the foundations or raiseborer 'pad' consideration should be given to: -</p> <ul style="list-style-type: none"> ▪ A design that meets civil engineering principles and standards. ▪ Bonding of concrete pads with solid rock in which there is no risk from remnant explosive misfires. ▪ Reaming against caving ground, in blocky ground or through geological discontinuities. ▪ Jammed rods or jammed reamer hole. ▪ The preferable removal of the reamer at the top of the hole on completion if practical and safe to do so.
Site Establishment and Mobilisation	Flooding of work areas and / or contamination of surface or underground environment from spillage / runoff of drilling mud, oils or contaminated water.	Ensure the design and installation of sumps, settling ponds and pumping systems for the raiseborer chamber and bottom of the hole are adequate, and effective maintenance program are planned.
Site Establishment and Mobilisation	<p>Establish services on time to meet design specifications and project milestones.</p> <p>Services may include:</p> <ul style="list-style-type: none"> ▪ Lifting / rigging points ▪ Compressed air ▪ Water ▪ Electricity 	<p>Adequate planning for the provision of services should be made. The project activity schedule should clearly identify when and where services should be installed.</p> <p>A risk assessment should include failure to provide any of the listed services. Adequate control measures may be put in place or planned for.</p> <p>Electrical installations should meet appropriate standards.</p> <p>Particular consideration should be given to the provision of effective communications between the bottom of the hole and the raiseborer. A planned response should be determined if failure of the communications system occurs at critical times. This should be included in the Safety Management System TARP.</p>

	<ul style="list-style-type: none"> ▪ Ventilation ▪ Communications <p>Sumps / Pumps</p>	<p>Consideration should be given to providing duplicate communications systems and, if possible a dedicated radio channel.</p> <p>Consider drilling an independent small diameter hole or utilising a geotechnical exploration hole located outside the final raisebored hole position in which a dedicated phone line may be installed.</p> <p>Consider the installation of low voltage lighting.</p>
Site Establishment and Mobilisation	<p>The transportation of the raiseborer and associated equipment may involve significant hazards.</p> <p>These include:</p> <ul style="list-style-type: none"> ▪ Dimensions and weight of components exceed bridge & access limitations ▪ Unplanned movement of equipment ▪ Blocked egress ▪ Failure of slinging and rigging equipment ▪ Failure or damage of high pressure hydraulic hoses & fittings ▪ Injury through poor manual handling practices ▪ Hazards associated with impact by moving equipment and gear. ▪ Heightened levels of frustration by other mine users due to restricted mine access while large loads are being transported via normal travel ways to an underground site. 	<p>Consideration should be given to the transportation of the raiseborer and associated equipment to the site(s) being carried out in a planned and systematic way. Hazards should be identified and control measures planned prior to work commencing. Consideration should be given to:</p> <ul style="list-style-type: none"> • Ensuring equipment weights and dimensions are within limitations (bridges, power lines, road conditions) • Utilising an escort vehicle / person during transportation. • Taking measures to ensure any noise limitations are not exceeded. Erection of sound barriers at the raiseborer site and the use of rubber buffers when handling and stacking rods may be appropriate. • For sites on surface, consultation with the community and near neighbours should be considered. • Ensure the site is secured to prevent unauthorized entry of persons or wildlife. <p>The order and timing in which equipment is delivered to the site may result in additional hazards caused by rehandling or inappropriate storage or confinement of the work area.</p> <p>In order to assess the hazards associated with this phase of the project, the Principal should ensure that the contract scope clearly describes the means of transporting equipment to the raiseborer site(s). Tenderers should have a good understanding of the hazards involved prior to submitting a tender. Ensure that rod-handling clamps are regularly inspected for wear and are fully maintained to minimise the risk of dropping rods.</p> <p>Ensure that all slinging and rigging equipment is certified and managed.</p> <p>Safe Work Procedures and planned controls for this work should be developed after completing a risk assessment. All identified hazards, Safe Work Procedures and controls should be developed and communicated prior to work commencing.</p>
Site Establishment and Mobilisation	<p>Adverse weather conditions for surface raiseborer sites.</p>	<p>Controls may be required to address the hazards associated with adverse weather conditions. The Environmental Monitoring program of the mine's or contractor's Safety Management System should specify procedures to minimise such risks.</p> <p>The Safety Management System should include lightning protection and a TARP for storm prone sites or seasons.</p>

ELEMENT: PILOT HOLE DRILLING

A pilot hole should break through on schedule within acceptable tolerance of the planned location without damage to any installed services. There should be no risk to persons from falls of ground at, or adjacent to, the break through position or disruption to the ventilation circuit.

Activity	Issues to be considered	Notes and possible controls
Pilot Hole Drilling	<p>Multiple or severe corrections when directional drilling of the pilot hole (or diamond drilled geotechnical hole) may result in adverse stresses on the drill string during the reaming operation.</p> <p>Enlarging a directionally drilled hole.</p>	<p>Consideration should be given to determining acceptable deviation tolerances in the pilot hole drilling prior to commencement of the hole. These tolerances should be stated in the contract documentation. Also, planned corrective actions should be established when certain triggers occur. These trigger levels and predetermined actions should be documented and supported by justifications through relevant data and calculations.</p> <p>Consideration should be given to the type of drill used to increase the diameter of a directionally drilled hole to full pilot hole size. Should a hammer rig be used with conventional rods, the stiffer raiseborer rods may jam in the hole.</p> <p>Consideration should be given to preferably utilising directional drilling for deep pilot holes. Tooling is available to drill 16in diameter pilot holes in a single pass.</p>
Pilot Hole Drilling	<p>Missing the planned target – particularly when directional drilling is not utilised.</p> <p>Locating a pilot hole that has missed a target.</p>	<p>A competent surveyor should rigorously check the setting up and alignment of the raiseborer. This should be carried out both prior to, and immediately after, collaring of the pilot hole and before drilling continues.</p> <p>Particular circumstances and triggers that would/which initiate realignment of the raiseborer, should be decided and included in the contract scope.</p> <p>Consider incorporating contingency plans in the project scope should a target be missed. Methods employed to locate a pilot hole that has missed a target depend on the following variables:</p> <ul style="list-style-type: none"> ▪ Length of the hole – longer the hole the lower the level of confidence in predicting actual location ▪ Location, frequency and orientation of geotechnical features intersected by the pilot hole ▪ Availability and location of adjacent development and development on intermediate levels ▪ Occurrence and flow rates of groundwater intersected by the pilot hole ▪ Quality of groundwater – possibly acidic, radioactive, high in salt content or unusually hot <p>Consideration may be given to utilising the following methods when locating pilot holes:</p> <ul style="list-style-type: none"> ▪ Locating the hole using gyro, radio, sonar, sonic, camera survey or other technique. ▪ Developing an access drive from intermediate level development to intersect the hole. This will then facilitate survey pick up and recalculation of the hole coordinates at the

Activity	Issues to be considered	Notes and possible controls
	Locating a pilot hole that contains water.	breakthrough elevation. If the pilot hole has the potential to contain water then controls should be established to minimise the risk of water inrush on breakthrough. These controls may include: <ul style="list-style-type: none"> ▪ Drilling diamond drill holes to intersect the pilot hole through securely bolted standpipes that are fitted with appropriately pressure rated gate valves. ▪ Filling the pilot hole with rock aggregate and mining towards the best-estimated position. ▪ Developing towards the best-estimated position using remote drilling techniques. This should incorporate sidewall water-cover drilling. A risk assessment should be carried out and a Safe Work Procedure developed, documented and communicated before mining commences.
Pilot Hole Drilling	At the top of the pilot hole, hazards associated with sudden releases of energy while flushing the hole may 'throw' cuttings at high velocity significant distances from the collar.	Attempt to eliminate this risk by engineering the collar configuration such that cuttings are kept clear of the hole. Frequent flushing can also reduce the extent of build up of cuttings in the hole. Utilise a correctly engineered and installed Blooie system. (<i>ref Atlas Copco Robbins Raise Boring Handbook</i>) If manual removal of the cuttings is required, complete a Job Safety Analysis for the task to identify controls to minimise the risks.
Pilot Hole Drilling	Potential injury by high pressure fluid injection	Ensure that all high pressure hoses and lines are inspected and, if necessary, replaced before and after mobilization of the equipment to the operational location. Ensure that operators are aware of hazards associated with injection by high pressure fluids (ref: Fluid Injection Protocol: www.resources.nsw.gov.au/_data/assets/pdf_file/0004/84505/FIProtocol.pdf)
Pilot Hole Drilling	Potential injury during rod-handling.	Consider the use of a risk assessment and /or a Job Safety Analysis to review rod-handling operation to develop appropriate controls and procedures. Each project may introduce unique hazards due to the development configurations and equipment used. Consider utilising a mechanical rod wrench handling system and a wrap around wrench for small diameter rods.
Pilot Hole Drilling	Rod rotation / sequencing Correct rod torque	Sequencing of the use of rods should be incorporated as part of the operation to minimise rod failure through repetitive exposure to high torque or high stress events. Establish an effective rod identification and management system to minimise errors. Such management systems could include a computer database of rod history and condition monitoring as well as auditing of on-site compliance to this system. Ensure that rods are torqued to design specifications for all stages of the project.
Pilot Hole Drilling	The planned pilot hole breakthrough position may contain reticulated mine services (air, water, electric cables, ventilation ducting) which could be damaged on breakthrough.	Consider the potential consequences of failing to remove or isolate services prior to breakthrough. Significant safety hazards and disruption to the mine operations may result. The contract scope should include the identification of installed services and information on isolation procedures.

Activity	Issues to be considered	Notes and possible controls
Pilot Hole Drilling	<p>Potential rockfalls/ground movement at, and adjacent to, the pilot hole breakthrough position.</p> <p>Implement controls prior to breakthrough of the pilot hole.</p> <p>Inspection of the breakthrough position.</p>	<p>The area surrounding the breakthrough position should be check scaled and, if necessary, additional ground support installed, prior to any person approaching the breakout position or attempting to breakout the pilot bit.</p> <p>At breakthrough there may be some localized falls of ground accompanied by a wash of drilling fluid. It is important therefore, that the immediate area be barricaded and cleared of people and that all people working in the area are aware of an imminent breakthrough.</p> <p>Controls which may be considered before breakthrough occurs include:-</p> <ul style="list-style-type: none"> ▪ Initial planning to take into account local roof conditions and other geotechnical or hydrological considerations. ▪ Installation of effective and, preferably independent and duplicated, direct real time communications system(s) between the top and bottom locations of the hole. ▪ Prior to commencing pilot hole drilling, the breakthrough position and planned drilling depth should be determined by a competent design engineer and/or surveyor. ▪ Any additional ground support as determined should be installed. ▪ The area should be barricaded off and appropriate signage installed. ▪ Procedures should be implemented to ensure sufficient warning is given to people working in the vicinity of the breakthrough. ▪ The weight on the drill bit should be reduced as breakthrough is approached. ▪ A water management plan is in place <p>Following breakthrough of the pilot hole, the raiseborer should be shut down and isolated and the breakthrough position inspected. The inspection should focus on localized back (roof) or wall (rib) failure and, in coal mines, for methane or other gasses emerging from the hole.</p>
Pilot Hole Drilling	<p>On breakthrough significant water flows may enter the breakthrough location.</p>	<p>Using estimates of water inflow obtained during the planning / design stage of the project, an adequate and effective water management plan should be established prior to pilot hole breakthrough. Consider the potential effect of additional water flows on the mine drainage and pumping system. Also, the design and operation of sumps should be reviewed to manage excess water from raiseborer cuttings during removal and disposal.</p>
Pilot Hole Drilling	<p>It may be necessary to re-collar the pilot hole bit in the floor of intervening development.</p>	<p>The optimum design for a raisebored hole sometimes involves the intersection of intermediate development and the re-collaring of the pilot hole in the floor. This is particularly common in raisebored slot raises in large multi-level open stopes in metalliferous mines.</p> <p>The controls for pilot hole breakthrough described above should be repeated on each occasion intervening development is intersected.</p> <p>Additional hazards may be identified in this configuration. These include control of drill cuttings and drilling mud after re-collaring, isolation of personnel from rotating drill rods in a remote location and control of groundwater from the completed section of the pilot hole. A Safe Work Procedure should be specifically developed for this operation.</p>
Pilot Hole	<p>Preparation of the reaming chamber (bottom</p>	<p>The design of the reaming chamber should provide adequate space to safely accommodate all</p>

Activity	Issues to be considered	Notes and possible controls
Drilling	of the hole).	<p>planned activities in the area. Planned activities should take into account contingencies for cutter inspection or replacement and head recovery operations if a drill string fails and rods and/or a reamer fall to the bottom of the hole.</p> <p>Additional ground support should be considered before the reamer is in position to support the brow area of the newly cut hole.</p> <p>Should the pilot hole miss the design breakthrough position, consideration should be given to additional mining and ground support to ensure reamer attachment and detachment operations are not compromised.</p>
Pilot Hole Drilling	Review the pilot hole drilling records.	<p>Review the pilot hole drilling records to identify additional hazards that affect the reaming phase. Compare the recorded pilot hole drilling records with all other available data used during the hole design phase.</p> <p>Consider collecting additional data from the pilot hole for final implementation considerations</p> <p>Develop controls to minimise future risks throughout the life cycle of the hole</p>

ELEMENT: REAMING AND CUTTINGS REMOVAL

Reaming and cuttings removal activities should be planned and managed systematically so as not to expose personnel to at-risk situations.

Activity	Issues to be considered	Notes and possible controls
Reaming and Cuttings Removal	Should the back (roof) at the breakthrough location not be regularly shaped and/or not perpendicular to the direction of the hole, the rod string and reamer may be subjected to stresses that could result in catastrophic failure.	Consideration should be given prior to moving the reamer to the breakthrough location to surveying the rock profile at the collaring position. Should the profile not meet defined tolerances, strip the area until the back (roof) is flat and perpendicular to the direction of the hole.
Reaming and Cuttings Removal	The potential for injury and equipment failure during preparation and assembly of the reamer in the reaming chamber.	Consideration should be given to the risks involved during the reamer assembly operation. The risk level can be higher due to the size and weight of components, the need to work in confined spaces, poor ventilation and the priority and urgency of the project. Consideration should be given to systematically using Job Safety Analysis to review every stage of the reamer assembly operation.
Reaming and Cuttings Removal	The following hazardous events have been known to occur during reaming: - <ul style="list-style-type: none"> ▪ Fatigue of operators ▪ Dust contamination of mine ventilating air ▪ Water inrush ▪ Mud/cuttings inrush ▪ Hang up of compacted cuttings ▪ Dropped rods and / or reamer (or parts thereof) ▪ Brow failure ▪ Ground failure of reamed hole face or sidewall ▪ Accumulation of methane ▪ Unplanned power cuts ▪ Pillar instability of adjacent mine areas 	Develop, implement and monitor an effective fatigue management plan. As part of the site establishment, provision for effective dust suppression / confinement should be made. This may consist of: <ul style="list-style-type: none"> ▪ Installation of water sprays ▪ Installation of a curtain adjacent to the brow ▪ Installation of two parallel curtains with water sprays between them. ▪ Installation of a ventilation door(s) to isolate the area. ▪ Installation of a dedicated ventilation fan & ducting to directly exhaust to a return airway. If a protective curtain is to be suspended at the brow for use during cutter inspections, complete the installation before collaring the reamer. Consideration should be given to control measures for hazards associated during the removal (bogging) of cuttings from the bottom of the hole and transportation to the planned disposal / storage

Activity	Issues to be considered	Notes and possible controls
	<p>should a hole deviate from its design path towards other underground development.</p>	<p>area(s). Controls may include:</p> <ul style="list-style-type: none"> ▪ Documented inspection procedures to assess the quantity of cuttings present and the status of the brow (open/closed/wet/dry/dusty/clear) ▪ Implementing a planned program of cuttings removal, with appropriate priorities, as an integral part of the mine operations schedule. Include and understand real time reconciliation of planned volume reamed v actual loader buckets v volume bogged ▪ Ensuring regular communication between the raiseborer operator and the person responsible for ensuring that cuttings removal occurs. This communication should include the current rate of reaming and the achieved progress compared to scheduled advance ▪ Scheduling inspections and/or cuttings removal at predetermined 'hold points' as reaming progresses. The 'hold points' should be calculated such that, providing cuttings are removed to a predetermined level, the brow never becomes closed ▪ Ceasing reaming and isolation/lock out of the raise drill during inspections and bogging to eliminate the risk of rod/reamer failure while persons are in the proximity of the bottom of the hole. ▪ Ceasing reaming should the brow become closed with cuttings. ▪ Should the brow become closed with cuttings, initiate an investigation into the factors causing this situation to occur and to introduce preventative measures. ▪ Provision of adequate cuttings storage and disposal sites / strategies. ▪ Provision of predrilled drain holes into the brow to intersect water running on the footwall of the raisebored hole ▪ Using a tele-remote loader for cuttings removal ▪ The loss of brow profile may introduce significant additional hazards during cutter inspections or changeouts and during demobilisation. Geotechnical assessments during the planning and mine development stages of the project should focus on the provision of ground support that ensures the brow remains intact during reaming. ▪ The loss of brow profile may adversely affect the installation standard of suspended protective barriers ▪ Consideration must be given to establishing procedures which minimise the risk of injury should there be ground failure from within the raisebored hole. These may include the installation of barricades and ceasing reaming during inspections of the bottom of the hole ▪ Inspections utilising remote controlled cameras may help eliminate the risk of injury to persons. ▪ Placing a bund in the access to the bottom of the hole at all times when cuttings are not being bogged.
Reaming and Cuttings	Catastrophic failure of the drill rods or reamer during reaming.	<p>Factors that could contribute to catastrophic failure of the reamer or drill rods include:-</p> <ul style="list-style-type: none"> ▪ Reaming large diameter inclined holes

Activity	Issues to be considered	Notes and possible controls
Removal	Does the Safety Management System include controls and procedures to address the hazards arising from these factors?	<ul style="list-style-type: none"> ▪ Excessive hole deviations in a directionally drilled pilot hole ▪ Incorrect pressure settings and/or adherence to design advance rates ▪ Poor maintenance of raiseborer and ancillary equipment ▪ Poor management of rod sequencing system ▪ Lack of catch rope on a vertical hole ▪ Inadequate training and competence levels of operators ▪ Inadequate establishment and / or implementation of QA procedures for the drill string and the reamer. These include non-destructive testing and rod rotation. ▪ Failure of the reamed hole sidewall or face ▪ Squeezing and distortion of pilot hole through ground movement ▪ Exceeding maximum designed operating hours for in-the-hole equipment ▪ Using an inappropriate or poorly designed reamer head – particularly in large diameter raises ▪ Using under-specified rods for a particular hole length / diameter or reamer size / design
Reaming and Cuttings Removal	<p>Cutter inspections and changes during reaming.</p> <p>Cutter condition.</p> <p>Risk assessment for cutter inspections / changes.</p> <p>Use of a physical shield or barrier.</p>	<p>During the planning/design phase of the project, the selection of cutters should include an assessment of estimated wear rates and condition of previously used cutters. Worn cutters should only be used if:</p> <ul style="list-style-type: none"> ▪ there is a high level of confidence that they will not require replacement before the hole is completed or ▪ replacement before completion of reaming is unavoidable <p>The use of new cutters may eliminate the hazards involved in lowering a reamer to the bottom of a partially completed hole for an inspection of cutter(s) condition or cutter replacement.</p> <p>Should it be necessary to lower the reamer to the bottom of the hole for inspection and/or replacement of cutter(s), a risk assessment of identified hazards should be undertaken and controls established to eliminate or minimise those hazards.</p> <p>Controls may include:</p> <ul style="list-style-type: none"> ▪ Never allowing personnel to position themselves beneath a vertical opening. ▪ Never allowing personnel to approach the brow beyond a predetermined 'exclusion zone' under any circumstances ▪ Erection of barricades and signs to prevent access to high risk areas or by unauthorized personnel ▪ Provision of effective lighting ▪ Completion of a risk assessment by all personnel involved in working at or in the vicinity of the reamer <p>Use of a physical shield or barrier that provides protection to personnel from ricochet rocks while working adjacent to the brow. Such a shield or barrier should not be relied upon to provide protection from direct impact from rocks or material falling under gravity from within the hole.</p> <p>The decision to utilise a particular design/configuration of barrier(s) should include consideration of the</p>

Activity	Issues to be considered	Notes and possible controls
	<p>Use of an inflatable barrier positioned in the raisebored hole above the brow to absorb all or part of the kinetic energy from falling rock or material</p>	<p>design specifications of the barrier, the risk of hole deterioration and the most probable worst case dynamic loading on the barrier. Consider the following:</p> <ul style="list-style-type: none"> ▪ The scope of a risk assessment for the use of an inflatable barrier positioned in the raisebored hole above the brow should include its use in conjunction with other physical shields or barriers to reduce the risk of injury to people engaged in cutter inspection, cutter changeouts or reamer removal. ▪ Should a means of access to the raisebored hole be available above the brow elevation, and additional or higher risk hazards are not introduced, consideration may be given to positioning a layer of suitable material on top of the inflatable barrier as protection from sharp impact. ▪ Inflatable barriers equipped with a top and side high strength 'protective layer (e.g. 'kevlar') may exhibit additional protection against abrasive wear and / or puncturing one or more of the bladders. <p>An inflatable barrier should:</p> <ul style="list-style-type: none"> • preferably be used in conjunction with a physical shield or barrier. ▪ be inflated prior to transport to the worksite and tested for significant leaks and inspected for structural damage and general condition. ▪ be designed to withstand and absorb the kinetic energy from the maximum potential impact by falling rock(s) ▪ be constructed to an inflated diameter which is within acceptable tolerances of the actual raisebored hole diameter ▪ be transported and installed using fit-for-purpose equipment ▪ be positioned in accordance with safe operating procedures ▪ not be installed until the availability of compressed air to the worksite can be guaranteed ▪ be maintained at a constant design air pressure using an air pressure regulator and a distribution manifold ▪ have adequate top and tail rope lengths to ensure personnel can work outside any exclusion zone at all times ▪ be installed with its suspension cable passing through a 'low friction surfaced ' pipe inserted into the inclined borehole into the raise. This will allow easier movement of the suspension cable during insertion into the borehole and reduce the risk of abrasive wear ▪ have all attachments to the balloon, including the inflation hose, completed before the balloon attachment points are positioned within the exclusion zone.

Activity	Issues to be considered	Notes and possible controls
Reaming and Cuttings Removal	<p>Hole completion – rock cap fails due to reaming too far before the reamer is lowered to the bottom of the hole for removal.</p> <p>Not possible to blast rock cap due to unacceptable risks.</p>	<p>The rock cap design depth should take into account geological and geotechnical conditions. In competent ground a ‘rule of thumb’ minimum depth of two raise diameters below the machine is often applied.</p> <p>If the failure of the rock cap is assessed to be an unacceptable risk then the pre-collar should be constructed and filled with suitably designed concrete.</p> <p>Consider mounting the rig on an extended reinforced concrete raft.</p> <p>Consider provision of designed and tested tie-off points to provide anchorage in the event of rig movement or rock cap failure.</p>

ELEMENT: DEMOBILISATION

Leaving a safe and secure site after safe removal of the reamer and all associated equipment and infrastructure from a completed raisebored hole.

Activity	Issues to be considered	Notes and possible controls
<p>Demobilisation</p>	<p>Removal of reamer – top of hole. Removal at the top of the hole is the preferred method, if practicable, as it eliminates risks associated with lowering the reamer to the bottom of a hole and persons working in proximity to a vertical opening.</p> <p>Consideration needs to be given to the weight and dimensions of the reamer head and the risks associated with lifting and manoeuvring large and heavy equipment safely.</p>	<p>Consideration should be given to establishing controls for the following hazards:-</p> <ul style="list-style-type: none"> ▪ Personnel falling into an open hole ▪ Head falling to the bottom of the hole due to inadequate attachment or slinging procedures or standards ▪ Foundations failure leading to machine instability and misalignment ▪ Falling materials, rubbish etc down the hole creating hazards at the bottom ▪ In Coal mines the creation of a hazardous zone if flame or contraband enters the underground workings from surface via a raisebored ventilation shaft. <p>Controls may include: -</p> <ul style="list-style-type: none"> ▪ Installation of an engineered cover or fencing and appropriate signs around the collar of the hole. ▪ Installation of fall protection equipment consistent with 'open hole' Safe Work Procedures. ▪ Prior to the reamer breaking through to surface, clearly designating the surface area adjacent to the collar with appropriate signs. Also, education of personnel as to the meaning and implications of the procedure. ▪ Implementation of rigorous housekeeping standards adjacent to, and at, the worksite. <p>All lifting points, lugs, chains shackles and other lifting equipment and accessories must be designed, tested and installed to withstand the maximum loading with appropriate safety factors The use of a correctly rated crane to lift a reamer head from a completed hole must be considered only after conducting a risk assessment to identify all hazards and establish effective controls. Consideration must be given to the estimation of the size of the reamer and the maximum lift weight – particularly if there is a risk of the load snagging or being impeded during the lift.</p> <p>Controls may include:</p> <ul style="list-style-type: none"> ▪ Valid certification of the mechanical condition of the crane ▪ Valid certification of the mechanical condition and weight limitations of all lifting attachments ▪ Valid certification of the crane operator's competency

Activity	Issues to be considered	Notes and possible controls
		<ul style="list-style-type: none"> ▪ Valid certification of the rigger and/or dogman's competency ▪ Identification and use of all site specific permits and authorizations ▪ Restricting access of unauthorized personnel to the worksite ▪ Ensuring adequate lighting/visibility <p>In underground situations where access by crane is not possible, consideration may be given to utilising a front end loader to lift the reamer from the hole. The risk assessment for this operation may include the following controls:</p> <ul style="list-style-type: none"> ▪ Documented risk assessment which includes the configuration, specifications and identification of all steps in the process ▪ Valid certification of the mechanical condition and weight limitations of the loader, it's hydraulic system and all lifting attachments ▪ Valid certification of the loader operator's competency ▪ Valid certification of the rigger and/or dogman's competency. ▪ Identification and correct use of all site specific permits and authorizations ▪ Restricting access of unauthorised personnel to the worksite ▪ Ensuring adequate lighting / visibility
Demobilisation	Removal of reamer (by unscrewing) at the bottom of the hole.	<p>Consideration should be given to breaking out the reamer remotely in order to eliminate the high level of risk when working under an open raisebored hole. Ensure that any equipment used for this task is fit for purpose and inspected prior to use.</p> <p>A decision to remove a reamer at the bottom of a completed hole should be made only after removal at the top of the hole has been determined not to be a practicable option..</p>
Demobilisation	Removal of reamer (by destructive cutting of a burn out ring or use of a thermal lance) at the bottom of the hole.	<p>Consideration should be given to identifying all potential hazards associated with this process. In addition to those hazards at the workplace, there may be indirect hazards caused by fumes and resultant variations to normal mine ventilation quantities and quality.</p> <p>Controls which may be considered include:-</p> <ul style="list-style-type: none"> ▪ Never allowing personnel to position themselves beneath a vertical opening. ▪ Clear definition of responsibilities and roles during the work ▪ Fit for purpose and well maintained equipment ▪ On hand fire-fighting equipment ▪ A fully operational and tested communication system between the top and bottom of the hole ▪ Provision of, and training in, all necessary personal protective equipment. This may include fall protection, respiratory protection, hot work protective clothing ▪ Provision of additional ventilation capacity ▪ Notification to the mine workforce that burning is to take place ▪ Clearing work surfaces of obstructions and trip hazards

Activity	Issues to be considered	Notes and possible controls
		<ul style="list-style-type: none"> ▪ Issuing of, and compliance with, all appropriate permits. (permit to work, hot work permit, site isolation ...) ▪ In coal mines, compliance with the relevant Codes Of Practice or exemptions from statutory regulations ▪ Establishment of an 'no go' exclusion zone at the bottom of the hole to minimise or eliminate the risk of injury from ricochet rocks ▪ Provision of a physical barrier to eliminate the risk of injury from ricochet rocks. The decision to utilise a particular design / configuration of barrier should include consideration of the design specifications of the barrier, the risk of hole deterioration and the most probable case dynamic loading on the barrier. ▪ Development of techniques and procedures which maximize the length of the lance. <p>During the risk assessment of this activity consideration should be given to any potential 'pendulum swinging' effect of the drill string once the burn out ring has been cut.</p>
Demobilisation	<p>The transportation of the raiseborer and associated equipment may involve significant hazards.</p> <p>These include:</p> <ul style="list-style-type: none"> ▪ Dimensions and weight of components exceed bridge & access limitations ▪ Unplanned movement of equipment ▪ Blocked egress ▪ Failure of slinging and rigging ▪ Failure or damage of high pressure hydraulic hoses & fittings ▪ Injury through poor manual handling practices ▪ Hazards associated with impact by moving equipment and gear 	<p>Controls for hazards during demobilisation are similar to those during the site establishment phase. A review of the site establishment activities should be conducted and the outcomes incorporated into revisions to any Safe Work Procedures that are applicable to demobilisation activity.</p> <p>Possible controls are:</p> <ul style="list-style-type: none"> ▪ In order to assess the hazards associated with this phase of the project, the Principal should ensure that the contract scope clearly describes the means of transporting equipment from the raiseborer site(s). Tenderers should have a good understanding of the hazards involved prior to submitting a tender. ▪ Use of fit-for-purpose equipment ▪ Measures to ensure any noise limitations are not exceeded. The use of rubber buffers when handling and stacking rods may be appropriate. ▪ For sites on surface, consultation with the community and near neighbours should be considered. Ensuring equipment weights and dimensions are within limitations (bridges, power lines, road conditions) ▪ Utilising an escort vehicle / person during transportation. ▪ Ensuring the site is secured to prevent unauthorized entry of people
Demobilisation	<p>The project design and scope should include provision for the securing of the top and bottom areas of the open hole</p>	<p>Methods for securing the area must take into consideration the full life of the hole. Provision may be necessary for future access or inspections. These should be designed once a risk assessment of all identified hazards has been completed and the resultant controls incorporated into the design.</p>

Activity	Issues to be considered	Notes and possible controls
		For mines near residential areas, the elimination of the risk of children and other members of the community falling down an open hole should be incorporated into the risk assessment outcomes.