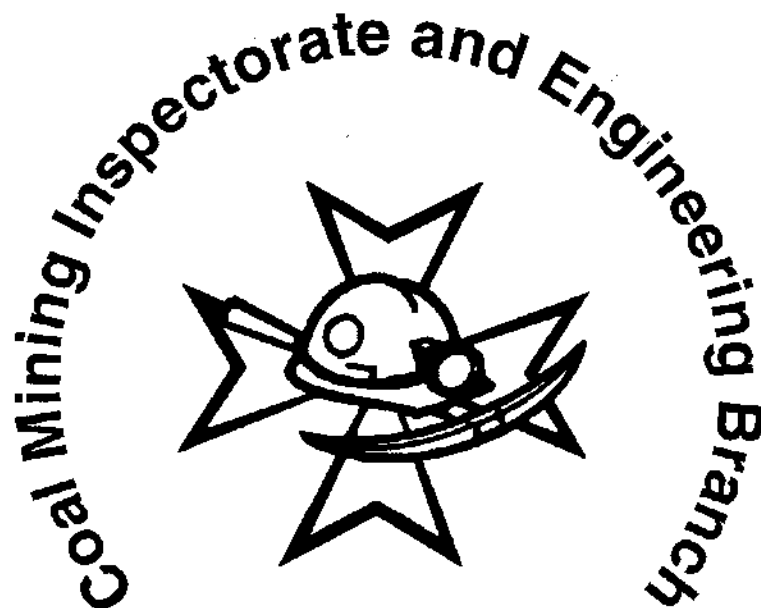


**Department of Mineral Resources
New South Wales**



**ROOF SUPPORT GUIDELINES
FOR
MASSIVE STRATA CONDITIONS
MDG 1017
OCTOBER, 1994**

FOREWORD

Roof support has been a basic issue in Coal Mines for many centuries. Often roof material and/or depth of mining have required man made support to be installed regularly to maintain stability. Support under these conditions is mandatory not optional.

However there are a sizeable minority of Coal Mines in New South Wales where the roof is massive and strong. Routine, regular support has not been required to maintain roadway stability. A study of accident statistics, for these mines, has shown that the number of mineworkers killed and seriously injured under massive roof is unacceptably high. Further there does not appear to have been an obvious improvement in these statistics over time.

I have considered it necessary therefore to:-

- i) review our approach to support under massive roof, and
- ii) prepare industry guidelines for the development and management of roof support under these conditions.

An industry team, consisting of Colliery Managers and Inspectors, headed by a Senior Inspector was formed to achieve this end. The team sought and received advice from other industry groups whilst formulating these guidelines.

The Team's finding presented in the form of guidance notes will allow for a rational and consistent approach to development of roof support under massive roof.

I commend the document to you.



B. R. MCKENSEY, 20.10.94
CHIEF INSPECTOR OF COAL MINES.

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1.0 PURPOSE

The purpose of this document is to:-

- i) Provide Colliery Managers and Inspectors of Coal Mines with a framework for the identification of key issues in the preparation of Support Rules, and
- ii) Provide Colliery Managers with a guide for the implementation of Support Rules as part of a managed system.

2.0 SCOPE

This document is limited to roof which is considered massive. It is not intended for use where a roof requires regular and consistent artificial support. However the document may be appropriate for interim situations where normally massive roof deteriorates and a regime of increased support density becomes necessary.

3.0 DEFINITIONS

Massive Roof

For the purpose of this document massive roof is any strata type which is able to consistently span headings and cut-throughs without the need for artificial support to maintain stability.

Examples of a massive roof are areas of conglomerate overlying the Great Northern seam and sandstones overlying the Wallarah, Lithgow and Katoomba seams.

Serious Bodily Injuries

Injuries requiring reporting and investigation under Section 86 Coal Mines Regulation 1982 as amended.

Support Rules

Rules prepared under Part III, Coal Mines Regulation (Support - Underground Mines) Regulation 1984.

4.0 BACKGROUND

Massive roof exists within several of the States coalfields. Various approaches have been adopted to mine and support this type of roof. Generally, support design has been limited to individual mine site history together with the views and opinions of mine personnel.

Given the evolution of systems management techniques and the availability of industry wide data, it is now appropriate to develop a single design approach for the support of massive roof. Whilst such an approach may not result in identical Support Rules in all mines across the state, the key issues and design philosophies needed to develop such rules will be consistent and verifiable.

5.0 ROOF CONTROL SYSTEMS - A MODEL

Development of a Roof Control system is, in principle, no different from the development of any risk management system. Therefore it is appropriate to use risk management methods in the preparation of a Roof Control Model. Such a model, developed following a multiple fatal collapse, is presented in figure 1.

It can be seen that Support Rules, are a sub-set of the system and are derived from the first 2 stages, namely:

- 1) IDENTIFICATION AND ASSESSMENT OF RISK
- 2) DEFINITION OF ROOF SUPPORT CONTROL STANDARDS

Each of the stages essential for a Roof Control System, outlined in figure 1, are now discussed. Issues identified within these stages need to be fully addressed prior to mining commencing.

5.1 STAGE 1

IDENTIFICATION AND ASSESSMENT OF RISK

The preferred method of risk identification and assessment is the use of objective data; that is, documented accident events. Controls then need to be developed and implemented to counter risks that have the potential to kill, maim or seriously injure mineworkers.

Table 1 lists and categorizes all fatal accidents since 1980 and all serious bodily injuries since 1982 in N.S.W. Coal Mines, where massive roof was the sole or most important causal factor.

From this data the following observations have been made:

OBSERVATION 1

Area Of Injury Within A Mining Layout

- * mine workers have been killed and seriously injured when their workplace has been:
 - i) influenced by a geological anomaly,
 - ii) at an intersection,
 - iii) influenced by goaf loadings (for the purposes of this document only, roadways up to 35m distant from the goaf edge).
- * no mine worker has been killed or seriously injured when his workplace has been a bord, except when a geological anomaly has also been present.

OBSERVATION 2

Fall Frequency and Injuries Sustained

- * falls of massive roof are relatively rare but have a very high potential for inflicting serious or fatal injuries.

OBSERVATION 3

Fall Behaviour

- * Average fall size is 2.4m x 2.0m x 0.2m.
- * Falls tend to be either:
 - a) in single pieces, located in the hatched area shown on Figure 2. Note that these falls do not occur on the road centre or on the immediate rib line. Actual examples are shown in Figures 3 - 5, or
 - b) cantilevered from the rib to some distance into the bord but rarely extending to the centre of the road. Actual examples are shown in Figures 6 - 7, or

- c) across the road but not close to the ribs, as shown by an actual example in Fig. 8.

OBSERVATION 4

Support Location And Type

- * Support installed in the hatched areas of a roadway shown in Fig. 2 can significantly reduce the potential of injury from falls.

- * Point anchor bolts appear adequate, if strategically placed, to support the typical fall configuration.

Support requirements based on these observations need to be incorporated within Support Rules.

5.2 STAGE 2

SUPPORT CONTROL STANDARDS.

Three approaches to establishing roof support control standards are shown on Figure 9. The "step standard" is recognised as the most practical and appropriate for massive roof conditions. This standard involves the establishment of a Support System capable of meeting typical or expected conditions and then being sufficiently flexible to respond to physical changes which require increased support.

5.3 STAGE 3

TARGETTED MONITORING PROGRAMS

This involves monitoring roof support activities to:

- a) confirm that actual behaviour of the roof strata and the performance of the support system complies to the design standard, and
 - b) detect in a timely manner any change in physical conditions where the support system must be extended and upgraded to ensure stability.
- * Implicit in section b) is the need to:-
 - i) accurately predict geological anomalies, and

- ii) constantly and consistently check for roof variation within the work place.

Once a change has been detected, a defined response must be made.

- * Options for action may be to change to a higher standard or adopt another remedial measure.
- * The targetted monitoring program should define:
 - the extent of responsibility for any remedial action;
 - guidance for officials as to when recovery activity, following an unexpected loss of roof control should commence;
 - reporting procedures to be followed when adverse changes in physical conditions are detected; and
 - criteria for a return to pre-change standards after a poor roof zone has been negotiated.
- * Targetted monitoring programs include activities such as:

Workforce observation via:-

 - * Visible changes in conditions
 - * Audible strata indicators
 - * Sounding roof
 - * Use of bolt holes as test holes - colour of cuttings, noise, detection of partings
 - * Roof fall experience

For a targetted monitoring program to be effective, criteria must be developed to characterise both worsening and improving conditions.

Also change detection techniques, together with their purpose, must be documented and effectively communicated to all involved in the operation of the targetted monitoring program.

5.4 STAGE 4

PREPARATION FOR IMPLEMENTATION

This involves:-

- * preparation of work methods needed to install roof support.
- * provision of appropriate, and sufficient, equipment, tools, materials etc. necessary to effectively implement the support system.
- * delivery of appropriate training to ensure competent mine personnel.

5.5 STAGE 5

IMPLEMENTATION

This stage ensures that roof support rules, roof support standards and a targetted monitoring program are in place via:

- * effectively communicated work methods
- * appropriate equipment, tools, materials etc.
- * provision of adequate numbers of competent personnel

5.5.1 STAGE 5 a. Monitoring for Change

This involves implementation of change monitoring processes as per the targetted monitoring program.

5.5.2 STAGE 5 b. Build on Controls or Step Up Standards

This involves responses to changing conditions as per the targetted monitoring program.

5.5.3 STAGE 5 c. Identify End of Change

This involves implementation of criteria necessary for return to standard roof control, including responsibility and decision processes as per targetted monitoring program.

5.6 STAGE 6

RECOVERY

This involves:-

Implementing recovery procedures for loss of roof control including responsibility, decision processes and data collection. Information obtained from recovery situations should be fed into roof support system review processes.

5.7 STAGE 7

SYSTEM AUDIT

This involves ensuring compliance to standards by auditing the performance of stages, in particular

- * appropriate application of roof control standards for prevailing conditions.
- * provision of competent personnel.
- * provision of appropriate equipment, tools, materials etc.
- * provision of work methods.

Appropriate audit methods, dependent on standard requirements, may include:

- * review of reports
- * job observation
- * interviews

Any audit must be followed by a report of non-conformity to requirements and follow up action to bring the system to within requirements.

5.8 STAGE 8

SYSTEM REVIEW

This involves verification that roof conditions remain as expected as per Stage 1; i.e. the risk environment has not significantly changed and the system continues to adequately manage identified risks.

Triggers for review of continued system adequacy need to be defined (triggers may be time based, mining milestone based, technology based or event based). For example:-

- i) annual reviews
- ii) end of panel reviews
- iii) introduction of new technology
- iv) a substantial roof fall.

It is important that critical roof control information is effectively captured and made available for continuous improvement of the system. Timely and effective reviews are a means of achieving this end.

6.0 CASE STUDY

Western Main Colliery, a unit of Novacoal Australia, mines the Lithgow seam under massive roof conditions. Colliery management, in conjunction with an industry consultant A.C.I.R.L., developed a Roof Support Management Plan during 1993. This plan has been implemented at the colliery and its development is presented as an example of how the principles in section 5.0 may be implemented.

It must be noted that the process described does not necessarily represent the best or sole approach to the development of a Roof Support management Plan. This description makes no judgement on the need for a consultant in development of the plan, nor does it recommend for or against the consultant mentioned in the process.

Plan Development

Figure 10 illustrates the flow chart set for the development of the plan.

6.1 RISK IDENTIFICATION

The approach adopted by the colliery was to accept a worst case scenario, that is, a person being injured by falling roof. The team developing the Plan recognised that quantification and identification of risk could be achieved by other approaches (such as in section 5.1.1), however they decided to accept the worst case method.

Having decided on the "global" approach, all possible consequences and causes for falls were analysed using the logic tree ("and"/"or" gate) method as shown by the example in Figure 11.

6.2 SUPPORT CONTROL STANDARDS

The Colliery used the approach outlined in section 5.2.

6.3 THE PLAN

Development of the plan, via a series of managed steps to address each of the identified courses of hazard, in the logic tree, then followed. Examples of such steps are shown in Tables 2 - 6. Appropriate roof Support Rules were developed based on issues of risk and a technical assessment.

6.4 MONITORING FOR CHANGE

Application of the appropriate standard of support is vital to success of any plan and the need to monitor for change is also a basic tenet. The Colliery developed "triggers" for change as shown in table 7. This table parallels the requirements of section 5.3.

6.5 IMPLEMENTATION

Section 5.4 and 5.5 outline implementation issues including effectively communicated work methods and training.

Especially important in this stage is the need to specify responsibility for initiating the various changes of standards in response to "triggers". Figures 12 - 14 outline elements of this approach.

Training at the colliery has been aided by a computer based training package, an example of which is shown in Fig. 15.

6.6 DOCUMENTATION

Formalizing information, both for action and auditing, is essential for any managed process. The Colliery, as part of the plan development, prepared modified report sheets to achieve this end, as shown in Fig. 16.

6.7 SYSTEM AUDIT

Section 5.7 details the need for systems audit and the Colliery have conducted such an audit to assess system effectiveness and monitor compliance as shown in Figs. 17 and 18.

6.8 SYSTEM REVIEW

The need for system review has been acknowledged by the colliery in their flow chart figure 10.

Roof Control System Model

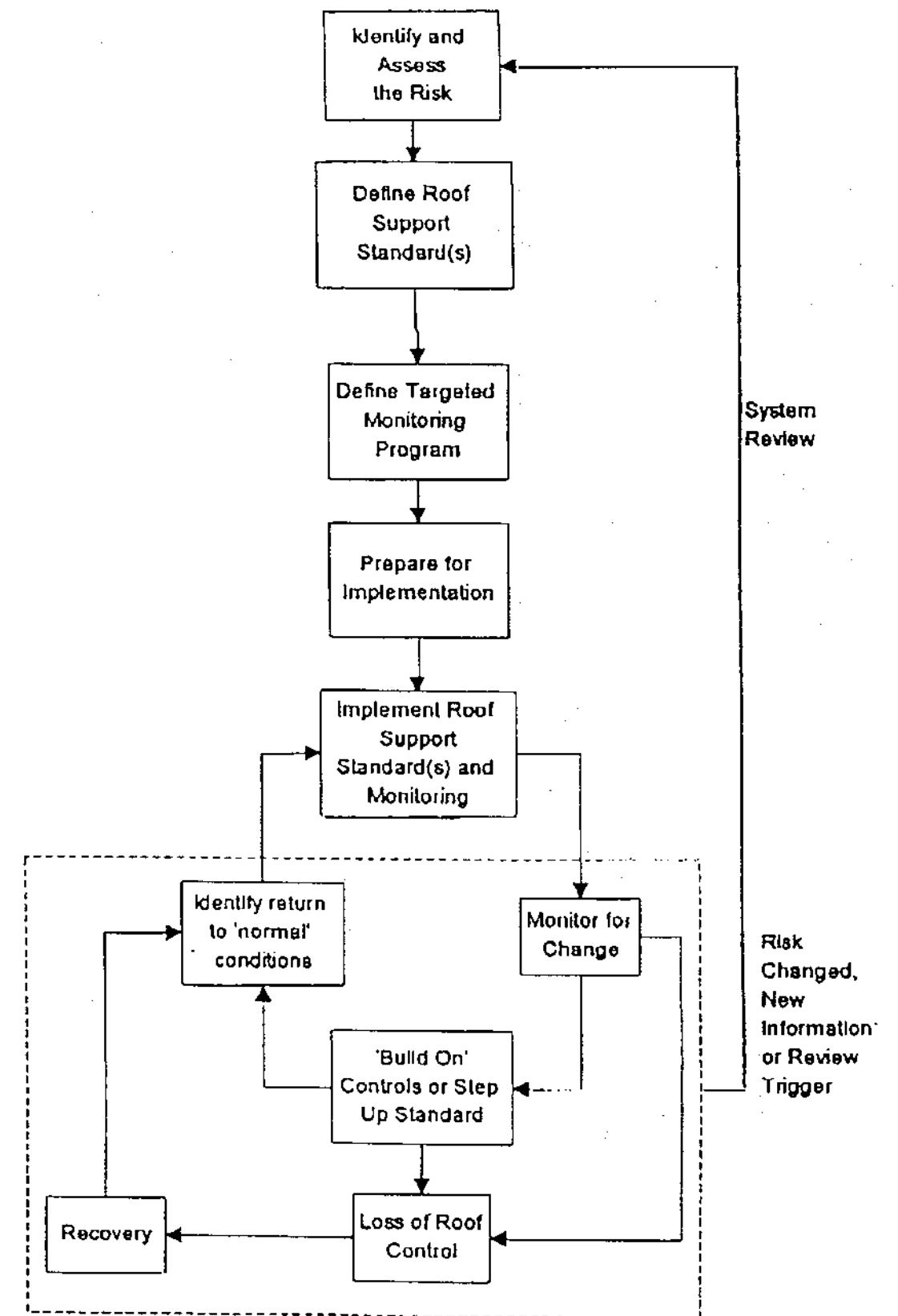


FIGURE 1

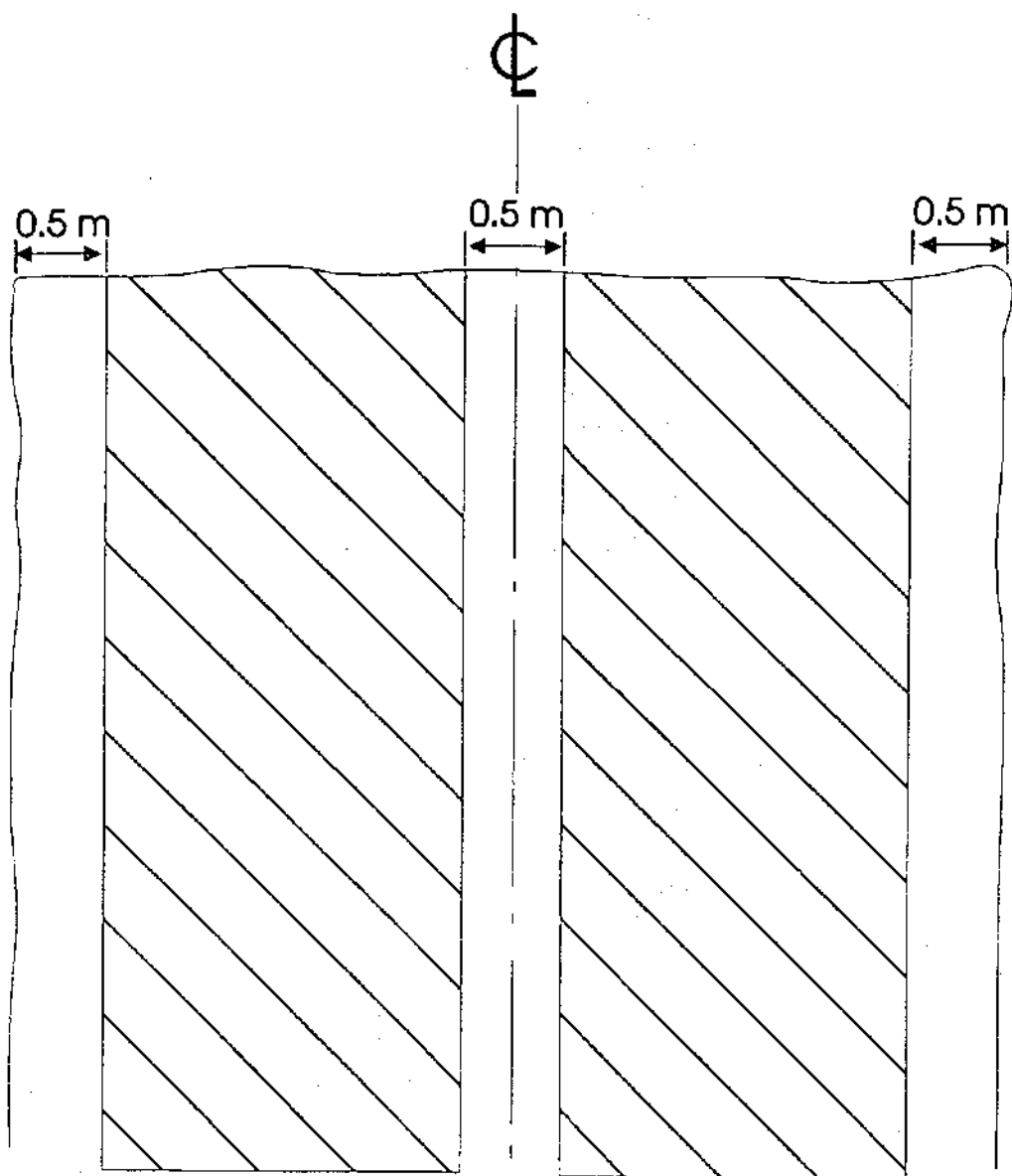


FIGURE 2

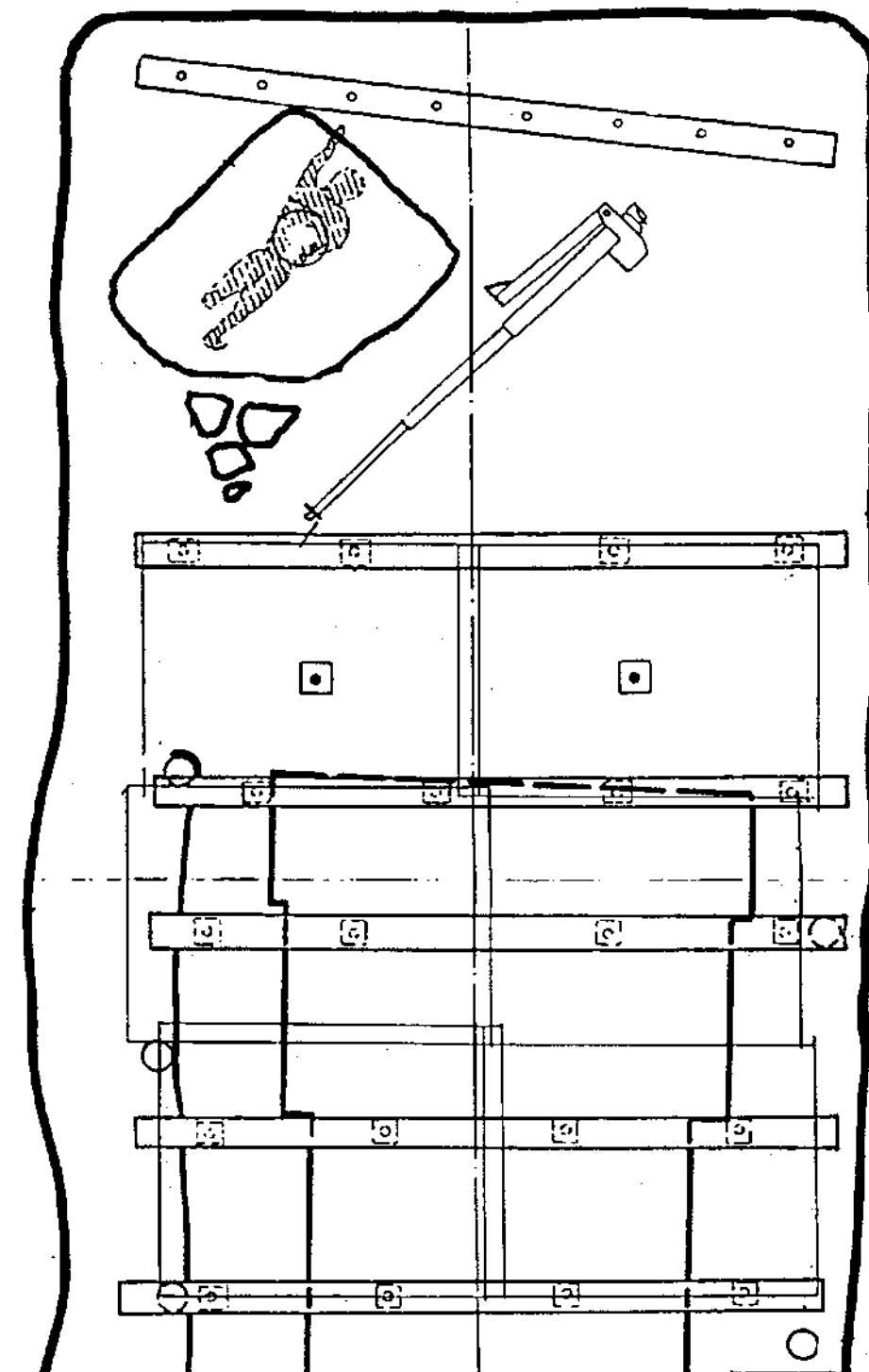


FIGURE 3

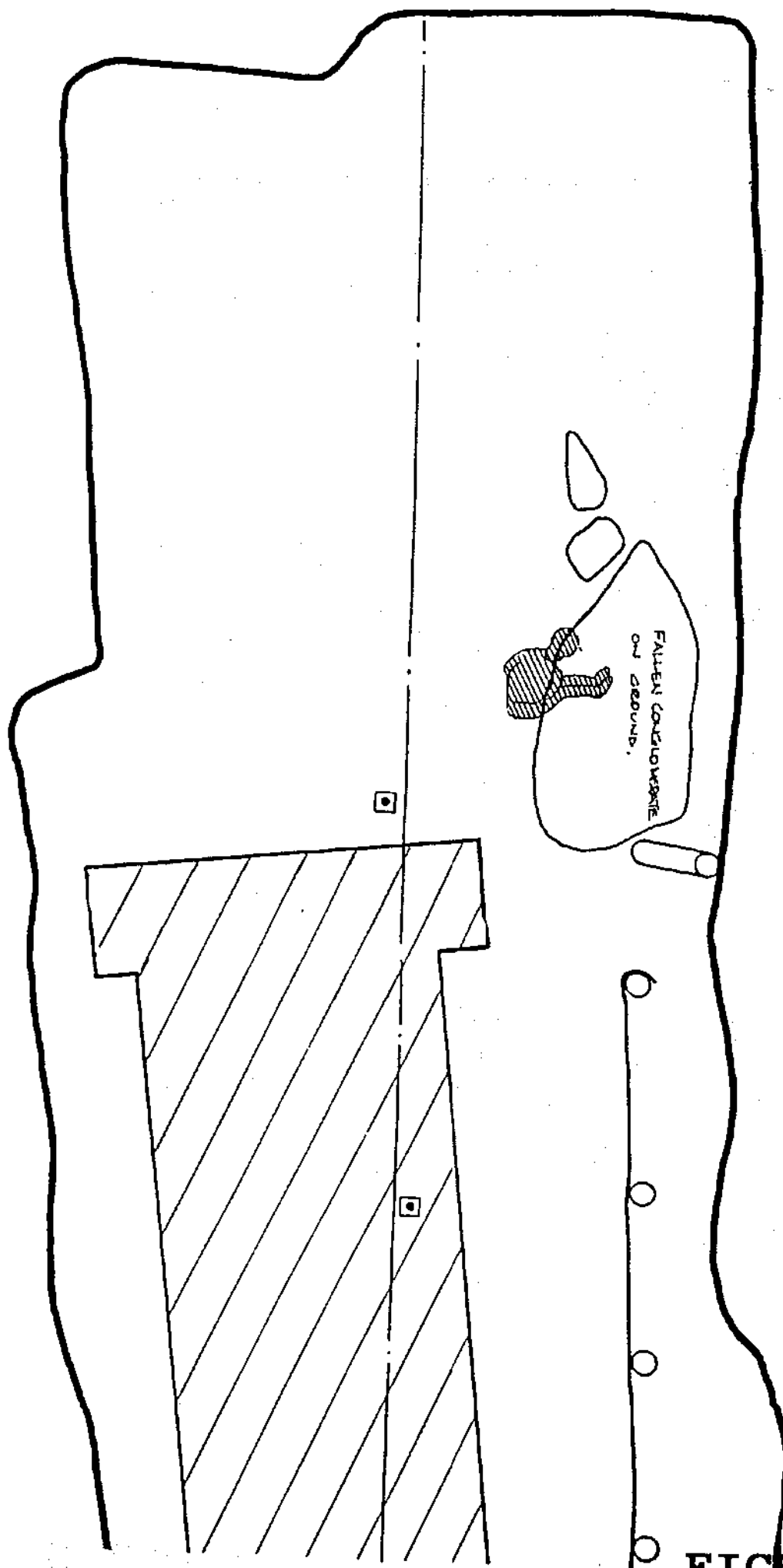
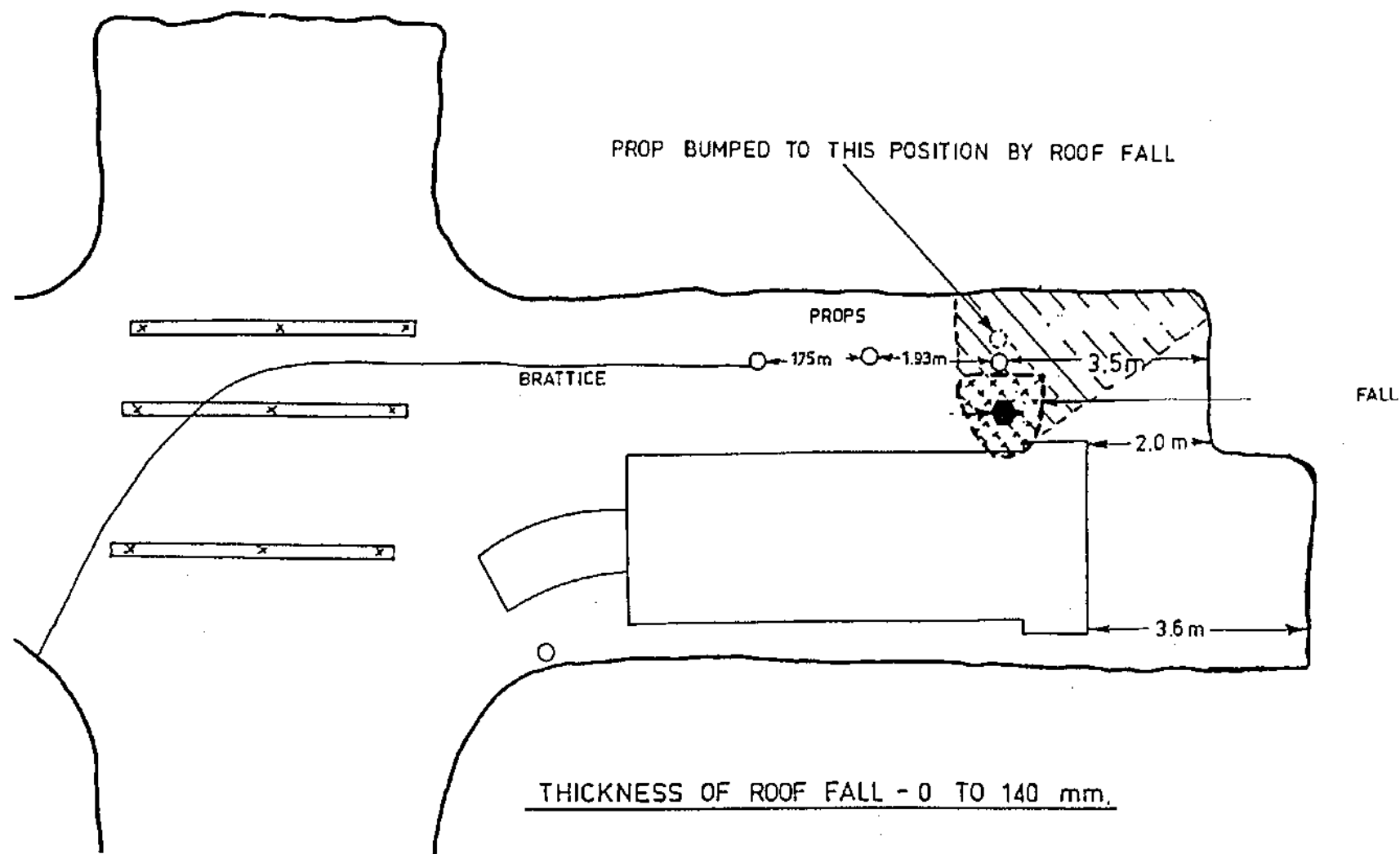


FIGURE 4

FIGURE 5



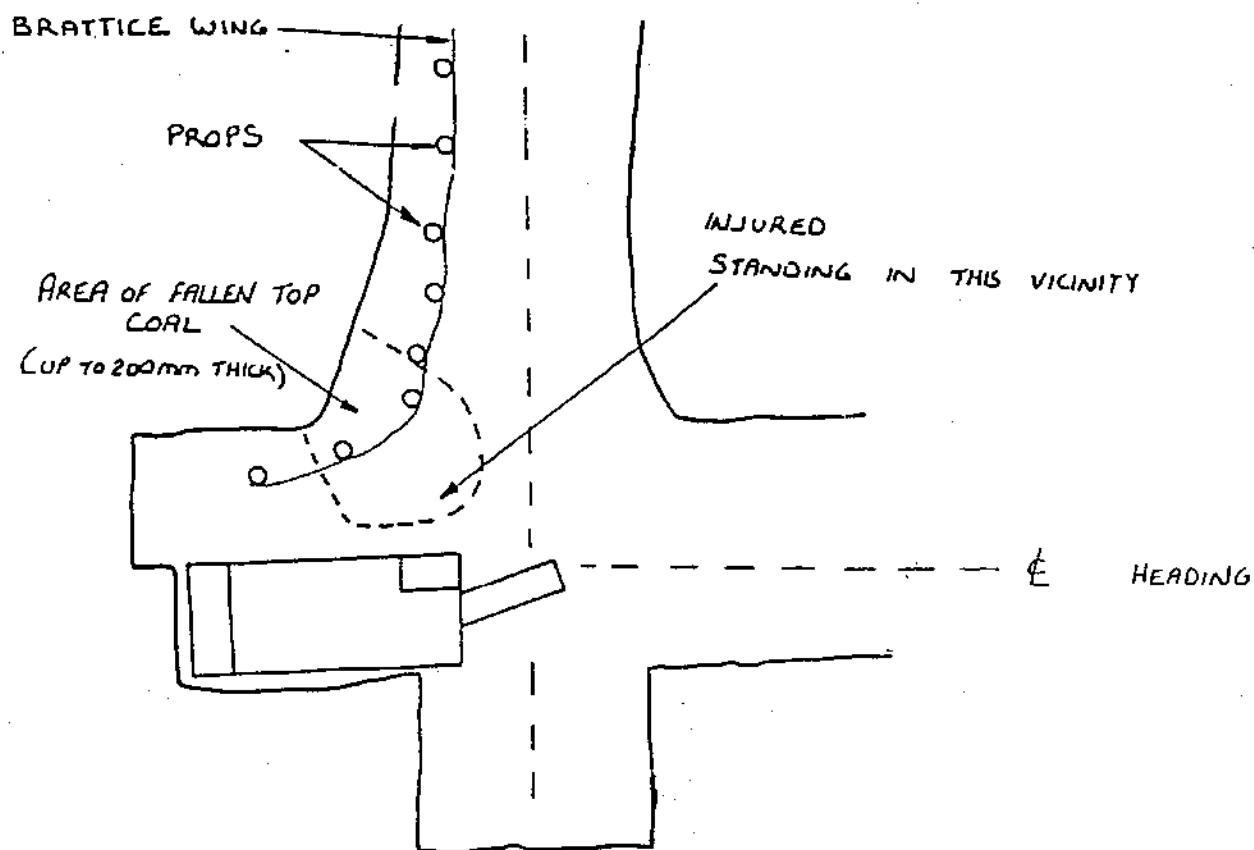


FIGURE 6

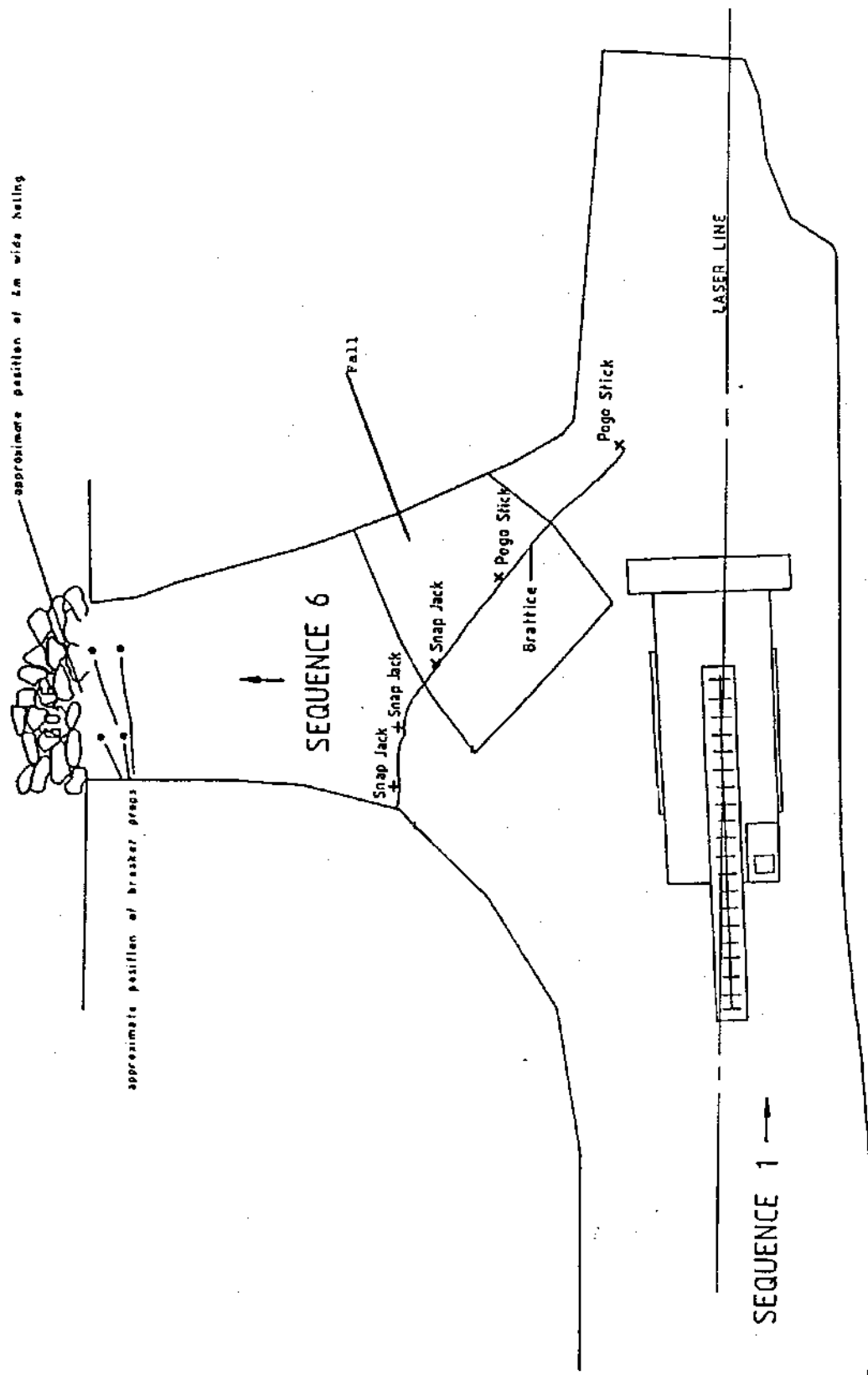


FIGURE 7

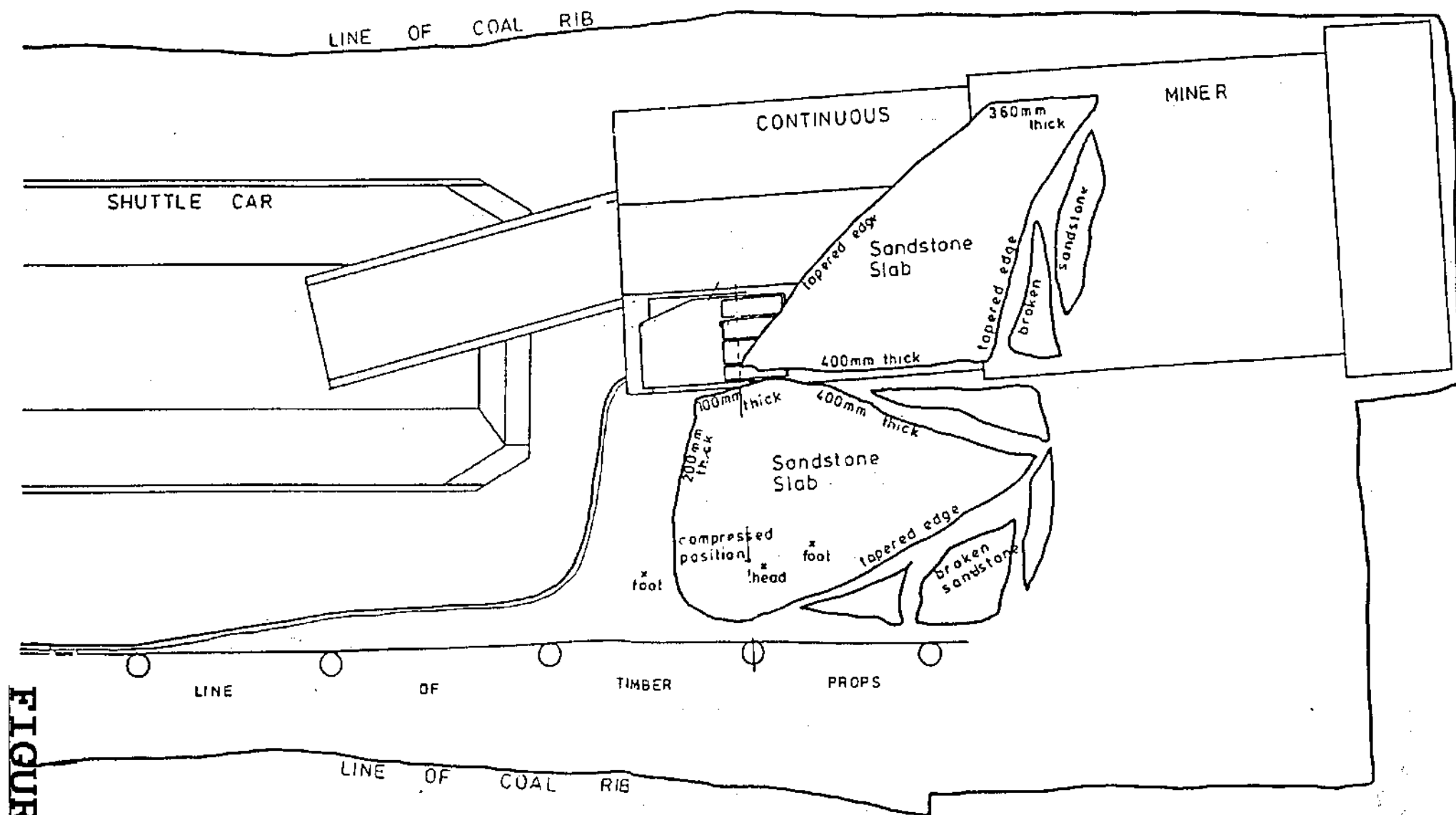
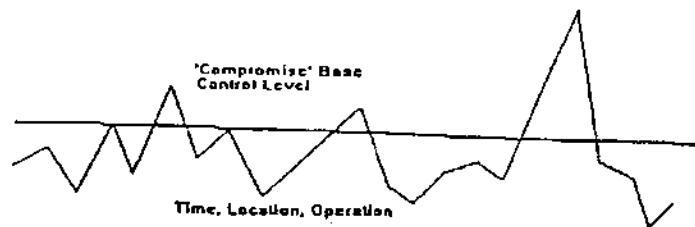
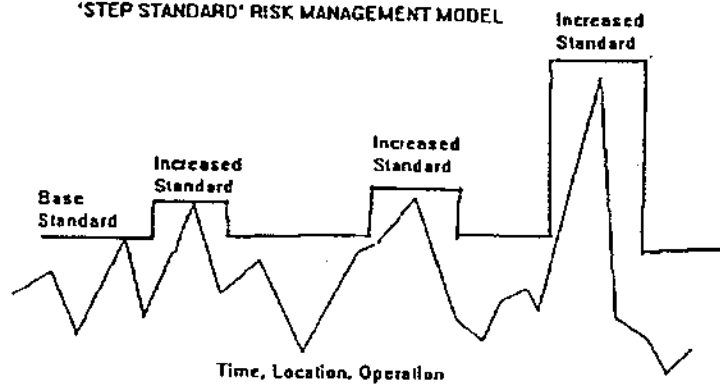


FIGURE 8

COMPROMISE RISK MANAGEMENT MODEL



'STEP STANDARD' RISK MANAGEMENT MODEL



RISK MANAGEMENT MODEL

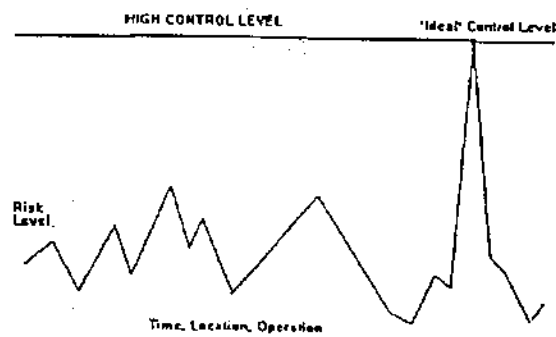


FIGURE 9

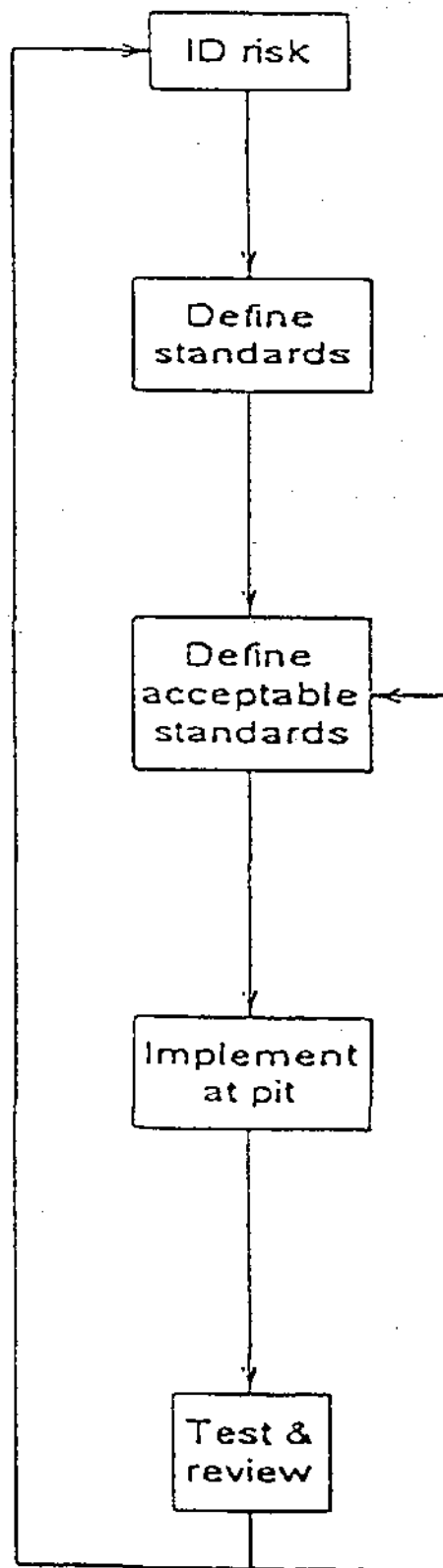
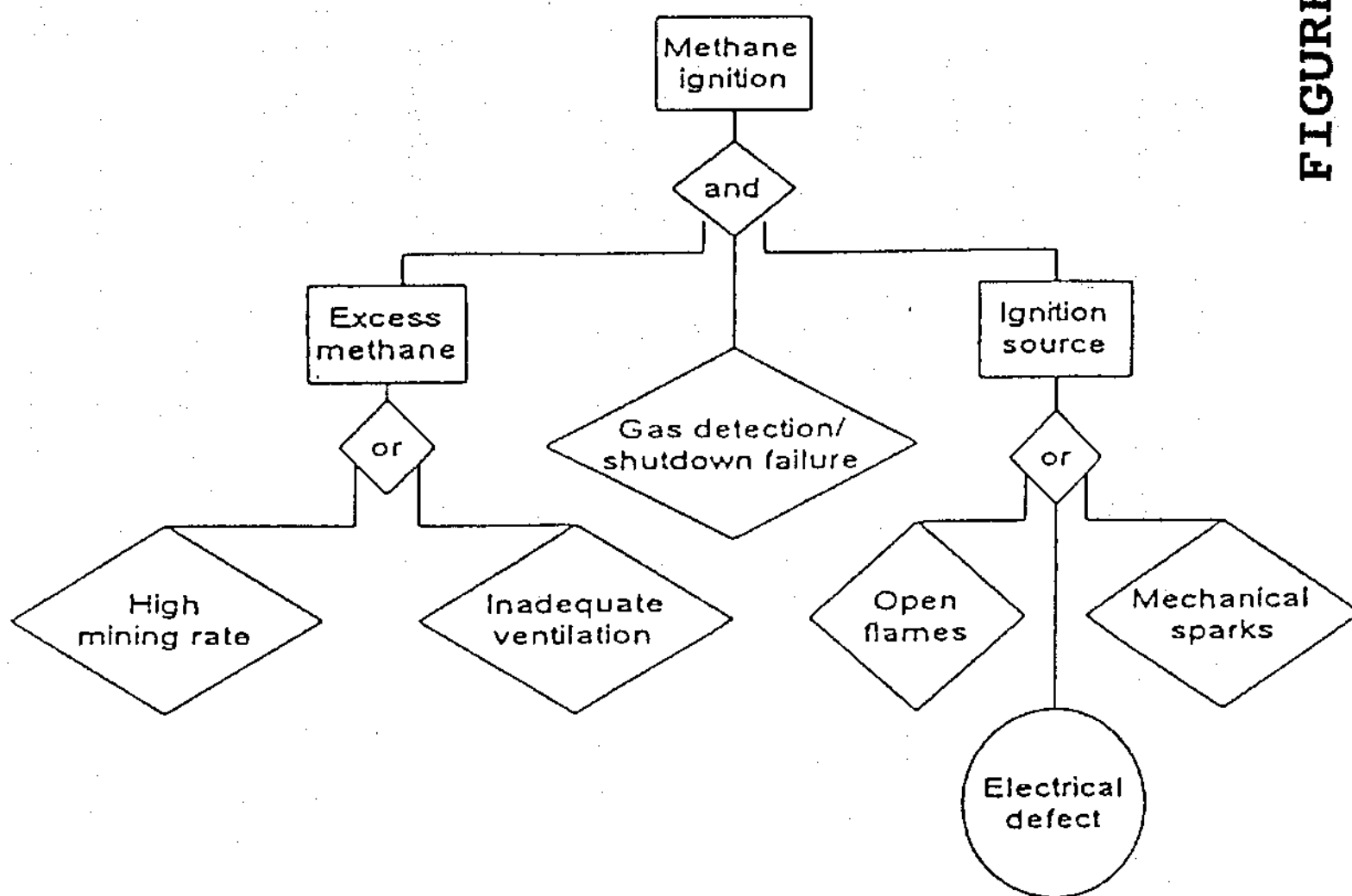


FIGURE 10

FIGURE 11



PROCEDURE DETAILS:

The generic procedure to be undertaken in any Risk Assessment or Evaluation done for or by Western Main, as part of the Risk Management Policy and subsequent Plan, will include the following:

1. Identification of Hazards
2. Estimation of the Risk
3. Consideration of Risk Acceptability
4. Evaluation of options to control the Risk
5. Selection of the most appropriate control option
6. Implementation of the selected option
7. Monitoring and/or Auditing of the activity to ensure the option has been successfully implemented.

This approach to Risk Assessment will be applied in the two following ways:

1. Informally, as a part of the way all Western Main or contractor personnel fulfil their job responsibilities, such as in the day to day job planning and decision making, including operator and trades work, pre-shift planning, engineering changes or additions, management activities, etc.
2. Formally, through systematic, team based, documented Risk Assessments. These will utilize the most appropriate analytical approaches for the task being examined, and will result in:
 - competent people (qualifications, induction, identification, monitoring, etc.)
 - fit for purpose equipment (specification, inspection, monitoring, etc.)
 - safe work methods (critical task procedures, roof sounding)
 - controlled work environment (noise, dust, etc.)
 - planned work environment (task planning, day-to-day planning, monitoring, etc.)

The specific methods used in the two applications will be as follows:

- For 1. Informally. As part of the Induction Programme for contractors or new employees, or ongoing training of current employees, the results of prior risk studies will be communicated and reinforced as considered appropriate. The concepts of a step-by-step, risk-based mental planning approach will be introduced to and used by all personnel to improve hazard and risk identification at all phases of the work.
- For 2. Formally. Participative, qualitative Risk Assessment methods that are appropriate to the defined assessment requirements such as Workplace Risk Assessment and Control (WRAC), Hazard and Operability Studies (HAZOP), Failure Mode Event and Criticality Analysis (FMECA) and Fault Tree Analysis (FTA) will be introduced and used by the relevant personnel.

WESTERN MAIN COLLIERY - JOB ANALYSIS & PROCEDURE SYSTEM

Job: Testing Roof

Date:

Authorised:

Tools/Equipment * 2kg wooden handle hammer * Safety glasses	Other requirements: * Person must be authorised by Manager in writing * Results to be entered on Deputies report immediately after finishing	
JOB STEPS	HAZARDS	CONTROL
Proceed to area to be tested.	Unexpected roof fall.	. Where possible stand under or close to a roof bolt, or known stable roof. . Always visually inspect roof before walking under. . Bar down any obviously loose material.
Strike roof with hammer head.	. Hammer strikes person . Operator slips/falls during test . Operator struck by roof fragments	. Check hammer head secure before use. . Reject any hammers with split handles . Stand on secure, level ground . Safety glasses
Listen for roof sounds.		
Record results on Deputies report.		

FIGURE 13

Documentation of Procedures/Reporting Systems
- Roof Support Management System

ROOF CONTROL RISK MANAGEMENT WESTERN MAIN COLLIERY

MINERISK

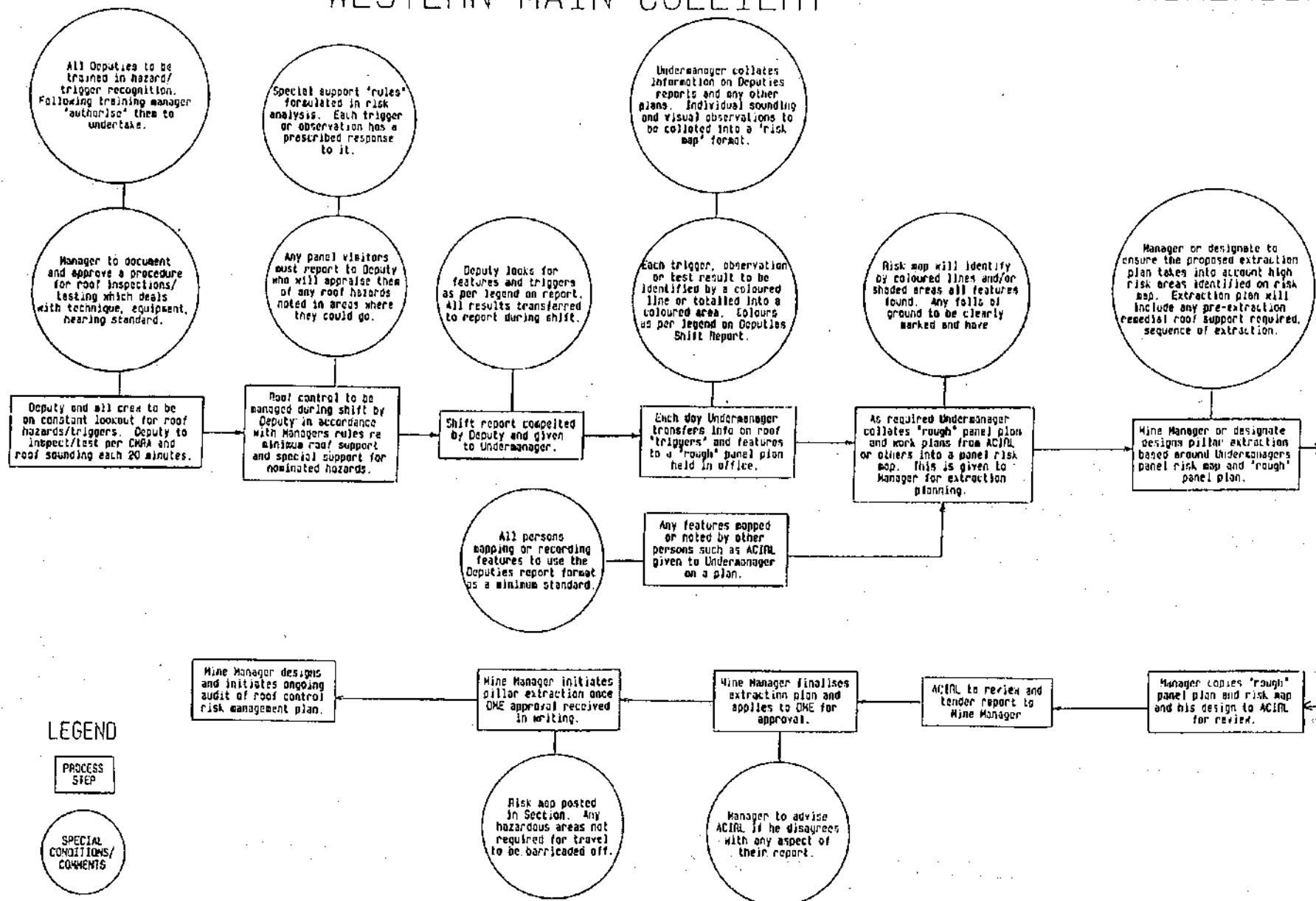


FIGURE 14

Trigger

Dull sound in roof, very localised (< 1/2 road width)

Dull sound across full roadway (for normal drivage and single breakaway)

Find a brown stain in roof

Find a white line in roof (edge of feather)

Incomplete caving (goaf not choked to rib line)

Mapping identifies structures in current roadways

Structures mapped in adjacent workings project into current ones

Menu

Hazard Style : Full Road



Determine starting point.

Start supports in solid ground as determined by sounding and supported by drilling.

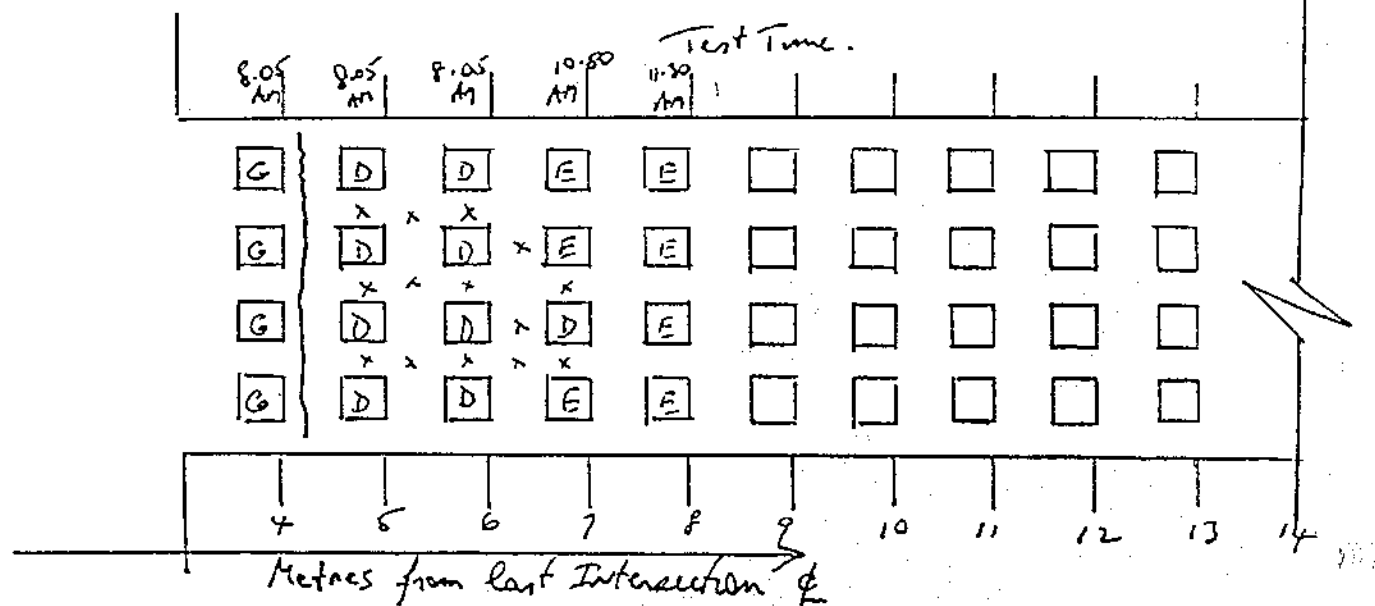
See managers rules for details.

Continue support as per rules till final support is in competent roof (defined by sounding and drilling).

If get to face and still drumming sound then cut no more than 2 straps (see support rules).

No double breakaway within 10m.

AMENDMENT TO DEPUTIES SHIFT REPORT



Legend for Sketches:

Visual Observations:

- W White line
- B Brown stain
- G Greasy back fault

Sounding Results:

- C Clear ring
- D Dull thud

Support:

- X Roof bolt/plate

2. SYSTEM EFFECTIVENESS

Since the implementation of the system, mining operations have remained in the Main West Panel of Western Main Colliery. The following points relate to the effectiveness of the system in the Main West Panel.

- (a) There have been no falls of roof in any roadways in the Main West Panel - either in existing (pre-driven) roadways, or newly driven splits (of which there have been very few).
- (b) There have been no anomalous or potentially hazardous roof structures or conditions identified in the panel, hence no requirement to install additional support systems.
- (c) The panel had been fully mapped (by survey and geotechnically), prior to extraction. Operating practices have been carried out in accordance with the issues and cautions raised by that mapping. In particular, special attention to mining through some of the irregular shaped and excessively wide intersections has occurred, with additional variations to the extraction sequence adopted in certain circumstances.

3. COMPLIANCE TO THE SYSTEM

The following comments are made in relation to the level of system compliance.

- (a) Mine plans showing results of mapping and extraction sequences are displayed in the crib room underground and in appropriate offices on the surface, and are carried by mine officials.
- conformity.
- (b) Summary charts of the Roof Support Management System are displayed underground and in appropriate offices on the surface.
- conformity.
- (c) Employees have been trained in the system.
- conformity.
- (d) Face workers, and in particular, the section deputy, displayed a keen awareness of the potential geotechnical hazards in the section, and the appropriate responses to them.
- conformity.
- (e) Roof sounding was being conducted routinely for assessment of roof integrity.
- conformity.
- (f) Records of roof sounding and any subsequent support installations (for assessment of effectiveness of the technique prior to next panel extraction) were not being kept.
- minor non-conformity*.

(* Since this is the last panel to be extracted in the life of the mine, this is only listed as a minor non-conformity, as there will be no call to assess the effectiveness of the method, since no further panels are to be mined.)

TABLE 1

**FATAL ACCIDENTS (1980 TO PRESENT) AND SERIOUS BODILY INJURIES (1982 TO PRESENT)
UNDER MASSIVE ROOF**

ISSUES					
Case No.	Geological Anomaly Present	Fall at an Intersection	Proximity to a Goaf	Size of Fall (m)	Nature of Fall
A	Fault 2m distant	n.a.	n.a.	2.7 x 1.3 x 0.30	Stone
B	n.a.	n.a.	20m distant	2.5 x 2.5 x 0.22	Stone
C	n.a.	3 way	8m distant	2.0 x 2.0 x 0.20	Stone
D	n.a.	n.a.	3m distant	unknown	Sticky Tops
E	Floater	n.a.	35m distant	4.0 x 3.0 x 0.20	Stone
F	n.a.	4 way	n.a.	4.0 x 4.0 x 0.25	Sticky Tops
G	Washout	n.a.	n.a.	1.0 x 1.5 x 0.15	Stone
H	n.a.	3 way	15m distant	1.4 x 0.9 x 0.13	Stone/Coal
I	Floater	n.a.	n.a.	3.5 x 1.5 x 0.08	Stone
J	S/Stone Lense	n.a.	n.a.	1.5 x 1.5 x 0.20	Stone
K	n.a.	4 way	n.a.	unknown	Sticky Tops
L	n.a.	n.a.	3m distant	unknown	Coal
M	n.a.	3 way	7m distant	1.5 x 1.5 x 0.25	Coal
N	n.a.	n.a.	3m distant	2.2 x 1.7 x 0.40	Coal

Step	How	Comments re Effectiveness	Actions in Plan
Identify the changes in geological risks (these will change with time and location)	Sounding roof with hammer	<p>Very effective always, but soundings at any point can change.</p> <p>History says any change will occur within 12 hrs.</p> <p>Experience says sounding "depth" OK up to 1.8m. Sounding technique believed to be reproducible and standardised within deputies.</p> <p>Deputies...no ring → put up support... decided by deputy in consultation with underground manager.</p> <p>Regular testing for time dependent (coal extraction induced) deterioration in outbye roads in production panel.</p>	<p>Do sounding every 30 minutes as per CMRA this applies to new areas & preshift.</p> <p>Continue pit Custom & Practise.</p> <p>Increase deputies reports to record time & outcome of sounding tests.</p> <p>Initiate a test to demonstrate the sounding technique can find an anomaly with the 1.8m limit of the technique.</p>

MINERISK

Step	How	Comments re Effectiveness	Actions in Plan
Identify the changes in geological risks (these will change with time and location) c'ontd	Visual observations	<p>Looking for discolouration in roof chippings. If they go yellowish then it indicates a plane of weakness nearby... Always applies in saturated ground. About 10m notice provided.</p> <p>A visible "white line" in the roof is a plane of weakness.</p>	<p>Trigger for caution and to look for white line.</p> <p>If outbye areas sound OK (in test) then don't bolt. Begin bolting from line till next line found or sounding OK and drilling confirms to partings up to 1.8m.</p> <p>Geologists to confirm nature of planes of weakness associated with "white lines" including all identified geological features.</p>
Identify the geological risks (these will change with time and location)	Panel by panel. Mapping of structures (prior to extraction)	<p>Poor correlation (in detail) between geological features like swilleys, and condition.</p> <p>Used to define pillar extraction sequence by ID "bad zones" (4 panel so far done).</p> <p>Extrapolation distance of structures in other unmapped areas is untested.</p>	<p>Continue mapping.</p> <p>Mapping to trigger action and sequencing review by Manager and Staff followed by ACIRL review → Revised sequence plan submitted to district Inspector for approval.</p> <p>Mapping plan posted in panel.</p> <p>Mapping become criteria for extra support prior to extraction. Structures found in mining to be marked on extraction plan and ACIRL geologists to correlate these with mapping and prediction.</p>

Step	How	Comments re Effectiveness	Actions in Plan
Identify the geological risks (these will change with time and location) c'ontd	Sounding with hammer.		<p>Each panel undertake correlation of sounding technique with bore scope inspection.</p> <p>U'mgr to check deputies sounding report daily. Check for records of deputies inspections, and inconsistencies between sounding tests and reality of conditions.</p> <p>Mine plans to show geol, structure and roof support system. If any falls ... document.</p>
Identify changing people risks	Sound the roof	Potential from human error.	<p>Manager to define a procedure.</p> <p>Procedure will deal with ... technique, equipment, frequency, hearing standard, reporting.</p> <p>Select people to be trained.</p> <p>Manager to authorise people after training.</p>
	Crew respond to sounding.		<p>Deputy to recheck each 2 hrs and "sign off".</p> <p>Continue current practise.</p>
	Workers/visitors unfamiliar with roof fall hazards.		<p>Ensure this is incorporated in induction or on-going training.</p>
	Workers/visitors unfamiliar district hazards.		<p>CMRA requires people to report to deputy.</p> <p>No-road barriers placed.</p>

MINERISK

Step	How	Comment re Effectiveness	Actions in Plan
	Hazards not identified (old workings etc).		Outbye hazards have been cross-sticked off. Only people outbye of face are with officials.
	Known hazards, managers rules ignored.		Deputy to eject persons taking deliberate unsafe actions. Manager to implement a scheme of deterrents. Reinforce via on-going training. Deputy to council people for non severe breaches of mgrs rules. Eject persons for serious breaches.
	Correct person for job.		Identify people predisposed to errors/lapses. Mix such people with those more responsible.
	Inadequate training.		Continue refresher training. Ensure training for any new system.
ID changes in support system installation quality			Ask ARNALL to do periodic tests (6 mths). On-going internal resin tests.
Defining support standards (a) Base	Use history (prop every 2m O bolts) Ask ACIRL	Good till something happens. Extremely effective based on previous geotechnical input.	Definition of base standard. ACIRL to do statistical appraisal of history (and current geol mappings) impacts on future area. ACIRL to investigate factors of safety in roof beam.

Step	How	Comments re Effectiveness	Action in Plan
Defining support standards (b) Increased standard (there are 7 geol hazards and 2 physical ones. Also 3 geol triggers and 2 physical ones.)	Manager and ACIRL to work together ... review history.	Variable dependant on ability to identify change in risk/conditions.	Identify what areas/conditions need support. Training people to ID all the possible triggers (deputies to pillar ext'n course). Deputy to define type of hazard (change in risk) and select defined support standard (from a set, see later). If deputy not comfortable with making the decision then call in u'mgr. Write a set of managers rules for each identified hazards. Look at falls in mine to check height, confirm structures, size of blocks fallen. ACIRL to provide technical report on support densities for each hazard. Create a chart of triggers hazards and actions (appended).
Test & review	External audit		External audit 3 months · checks managers risk m't system working OK Triggers to show scheme not working · roof fall in operations · burried machines on 1st workings · sounding suddenly changes in areas where previously OK · visible roof deterioration

Trigger	Hazard Style	Action
Dull sound in roof, very localised ($< \frac{1}{2}$ road width)	Floater	Determine exact size and location. Clearly identify outline on roof clear identify (adopt safe practises). Support roof with bolts and butterfly plates (see Mgrs rules).
Dull sound across full roadway (for normal drivage and single breakaway)	Full Road	Determine starting point. Start supports in solid ground as determined by sounding and supported by drilling. See managers rules for details. Continue support as per rules till final support is in competent roof (defined by sounding and drilling). If get to face and still drumming sound then cut out no more than 2 straps (see support rules). No double breakaway within 10m.
Find a brown stain in roof	Caution	Look for white line to define more hazards. Reduce amount mined before sounding. Increase sounding frequency.
Find a white line in roof (edge of feather)	Geological Structure	See trigger actions.
Incomplete caving (goaf not choked to rib line)	Stress feather edge	Set additional breaker props as per managers rules.
Mapping identifies structures in current roadways	Geological structure	Support action as per 2.
Structures mapped in adjacent workings project into current ones.	Geological structure	Exercise caution. Additional sounding. Abandon such measures if not found within 1 pillar length of projected intersection.

TABLE 7