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DEPARTMENT OF MINERALS AND ENERGY

Minerals and Energy for Development and prosperity

MINE HEALTH AND SAFETY INSPECTORATE

GUIDELINE FOR THE COMPILATION OF A MANDATORY CODE OF PRACTICE TO COMBAT ROOF FALL ACCIDENTS IN UNDERGROUND COAL MINES

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Chief Inspector of Mines

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CONTENTS OF GUIDELINE

PART A: THE GUIDELINE

1. FOREWORD

1.1 The majority of accidents occurring at coal mines are as a result **roof falls**, gravitationally induced. Over the last few years the fatality rate pertaining to roof fall-related accidents has reached a plateau and no real or meaningful improvement has been attained.

1.2 In an initiative to solve this problem, a tripartite task group was established under the auspices of **MRAC**. The initial terms of reference of the task group were to investigate and identify root causes of roof fall related accidents. Current work practices and any compliance and/or non-compliance with regulations, standards, directives, guidelines and **COP**, and their impact on root causes were scrutinised. Research conducted into solutions under the direction of the Safety in Mines Research Advisory Committee (SIMRAC) was also examined.

1.3 Subsequent to the investigation it was concluded that, as a matter of urgency, a guideline for the compilation of a mandatory **COP** to combat roof fall accidents be produced. Due to the complexity and variability of conditions at mines pertaining to the design, geometry and **support** requirements, rigid and prescriptive guidelines would not be in the interests of rock related safety. An approach was adopted which allowed for local expertise, experience and knowledge on the mines to be effectively utilised. In addition, the position contribution of tripartism to initiate a process to combat roof related accidents would be enhanced.

1.4 This guideline is a generic document and is not intended to address the roof related accident problems, encountered on a particular mine.

1.5 This guideline supercedes the previous guideline for the compilation of a mandatory **COP** to combat rockfall and rockburst accidents in collieries, dated 20 November 1996.

2. THE LEGAL STATUS OF GUIDELINES AND COPs

2.1 In accordance with section 9(2) of the **MHSA**, an employer must implement a **COP** on any matter affecting the health and safety of employees and any other person who may be directly affected by the activities at the mine if the Chief Inspector of Mines requires it. In terms of section 9(3) of the **MHSA**, a **COP** must comply with the relevant guideline issued by the Chief Inspector.

2.2 Failure by the employer to prepare or implement a **COP** in compliance with this guideline is a breach of the **MHSA**. Any contravention of, or failure to comply with, a **COP** is not, in itself, a breach of the **MHSA**, except a contravention or failure by an employer that also constitute a failure to prepare or implement the **COP**. Since the **DME** does not approve **COPs**, its focus is

not to enforce them either. The focus of the **DME** is to ensure that employers provide healthy and safe working environments at mines, i.e. focusing on system failures and compliance with the **MHSA**, rather than enforcing compliance with the **COP**.

2.3 The fact that a contravention of, or failure to comply with the **COP** is not a breach of the **MHSA**, does not mean that such breaches will have no legal implications. As far the employer is concerned, there are numerous specific and general obligations on the employer in the **MHSA**, aimed at ensuring the health and safety of all employees and all persons who are not employees but who may be directly affected by the activities at the mine. Where any failure to comply with a **COP** also constitutes a breach of any of the employer's obligations under the **MHSA**, the employer could be liable to an administrative fine for such breach. An inspector could also issue various instructions to the employer and employees in terms of section 54 to protect the health or safety of persons at the mine. Failure by an employer to comply with such an instruction could render the employer liable to an administrative fine.

2.4 As far as employees are concerned, section 22 places a number of obligations on employees, including that they must take reasonable care to protect their own health and safety and the health and safety of other persons who may be affected by their conduct. Where a failure by an employee to comply with a **COP** would also constitute a breach of the employee's duties in terms of section 22 (or a breach of section 84, 86(1) or 88), the employee could be criminally charged for such breach. As is the case with employers, the inspectorate could issue instructions to employees in terms of section 54 and failure to comply with such an instruction constitutes a criminal offence.

2.5 Employers should deal with breaches by employees of the **COP** in terms of the mine's standard instructions and the employer's disciplinary procedures. This is not the responsibility of the State.

3. THE OBJECTIVE OF THIS GUIDELINE

The objective of this guideline is to enable the employer at every coal mine to compile a **COP**, which, if properly implemented and complied with, would reduce the number of roof fall accidents at the mine.

4. DEFINITIONS AND ACRONYMS

In this guideline for a **COP** or any amendment thereof, unless the context otherwise indicates: -

COP means Code of Practice;

DME means the Department of Minerals and Energy;

Ground Control means the ability to predict and influence the behaviour of roof strata in a mining environment, having due regard for the safety of the workforce and the required serviceability and design life of the mine;

Ground Control Districts means a portion of a mine where similar geological conditions exist which give rise to a unique set of identifiable roof strata-related **hazards** for which a common set of strategies can be employed to minimise the risk resulting from mining;

Ground Control District Plan means a plan on good quality transparent draughting material of a thickness not less than 0,08 mm indicating to a scale of 1 in 1500 all applicable **ground control districts** of the mine;

Hazard means a source of, or exposure to danger;

Hazardous Location means areas requiring additional attention and precautions where an increased risk of **roof falls** may develop (commonly also referred to as "Special areas" in rock engineering circles);

MHSA means Mine Health and Safety Act, 1996 (Act No. 29 of 1996);

MRAC means Mining Regulation Advisory Committee;

Permanent Support means **support** that, once installed, is not removed;

Pillar means roof left in situ during the mining process to **support** the local roof or to provide stability to the mine or portion thereof;

Primitive (Virgin) Stress means the state of stress in a geological formation before the stress field is altered by mining operations;

Risk means the likelihood that occupational injury or harm to persons will occur;

Rock Engineering means the discipline that applies rock mechanic principles;

Roof Fall means a fall of a roof fragment or a portion of a fractured roof;

Roof Mass means the total mass of the roof as it exists in place, taking into account the intact rock material, groundwater, as well as joints, faults and other natural planes of weakness that can divide the roof into interlocking blocks of varying sizes and shapes;

Rock Mechanics means the scientific study of the mechanical behaviour of rock and rock masses under the influence of stress;

Significant Roof-Related Risk means the likelihood that the harm from a particular **hazard** will result in the death or permanent disability of a person.

Support means a structure or a structural feature built into or around an underground excavation to maintain its stability;

Temporary support means **support** that will be removed;

Roofbolt (support) means the generic "rockbolt", plus flexible forms such as "cable anchors";

5. SCOPE OF GUIDELINE

5.1 This Guideline covers the significant health and safety aspects associated with **roof fall hazards** in underground coal mines.

5.2 The Guidelines covering the four principal mining methods are: -

5.2.1 16/3/2/1-A3 "----- Tabular Metalliferous Mines";
5.2.2 16/3/2/1-A4 "----- Underground Coal Mines";
5.2.3 16/3/2/1-A5 "----- Massive Mining Operations"; and
5.2.4 16/3/2/1-A6 "----- Surface and Openpit Mines"

6. TASKGROUP MEMBERSHIP

6.1 This guideline was prepared by the **MRAC** Task Group on Rockfall and Rockburst Accidents in Tabular Metalliferous Mines.

Mr. J E KOTZE (Chairperson)	-	State
Dr. W K RYMON-LIPINSKI	-	State
Mr. K R NOBLE	-	Employers
Mr. J W KLOKOW	-	Employers
Mr. R C MORE O'FERRALL	-	Employees

6.2 The following organisations were also consulted: -

Dr. J N van der Merwe	-	SANGORM
Mr. H C van Zyl	-	MRAC
Mr. P J Terbrugge	-	S.R.K.

PART B: AUTHOR'S GUIDE

1.1 The **COP** must, where possible, follow the sequence laid out in Part C: Format and Content of the mandatory **COP**. The pages as well as the chapters and sections must be numbered to facilitate cross-referencing. Wording must be unambiguous and concise.

1.2 It should be indicated in the **COP** and on each annex to the **COP** whether -

1.2.1 the annex forms part of the **COP** and must be complied with or incorporated in the **COP** or whether aspects thereof must be complied with or incorporated in the **COP**; or

1.2.2 the annex is merely attached as information for consideration in the preparation of the **COP** (i.e. compliance is discretionary).

1.3 When annexes are used the numbering should be preceded by the letter allocated to that particular annex and the numbering should start at one (1) (e.g. 1, 2, 3, A1, A2, A3,….).

1.4 Whenever possible illustrations, tables, graphs and the like, should be used to avoid long descriptions and/or explanations.

1.5 When reference has been made in the text to publications or reports, references to these sources must be included in the text as footnotes or side notes as well as in a separate bibliography.

PART C: FORMAT AND CONTENT OF THE MANDATORY COP

1. TITLE PAGE

The **COP** should have a title page reflecting at least the following:

1.1 the name of the mine;
1.2 the heading of the **COP** (for example, Mandatory **COP** to Combat Roof Fall Accidents in Underground Coal Mines);
1.3 a statement to the effect that the **COP** was drawn up in accordance with **DME** guideline, reference no. 16/3/2/1-A4 issued by the Chief Inspector of Mines;
1.4 the mine's reference number for the **COP**;
1.5 effective date; and
1.6 revision dates.

2. TABLE OF CONTENTS

The **COP** must have a comprehensive table of contents.

3. STATUS OF MANDATORY COP

Under this heading the **COP** must contain statements to the effect that -

3.1 the mandatory **COP** was drawn up in accordance with **DME** guideline Reference Number **DME** 16/3/2/1-A4 issued by the Chief Inspector of Mines;

3.2 this is a mandatory **COP** in terms of sections 9(2) and (3) of the **MHSA**;

3.3 the **COP** may be used in an accident investigation/inquiry to ascertain compliance and also to establish whether the **COP** is effective and fit for purpose;

1.1 the **COP** supersedes all previous relevant **COP**; and

1.2 all managerial instructions or recommended procedures (voluntary **COP**) and standards on the relevant topics must comply with the **COP** and must be reviewed to ensure compliance.

4. MEMBERS OF DRAFTING COMMITTEE

1.1 In terms of section 9(4) of the **MHSA** the employer must consult with the Health and Safety Committee on the preparation, implementation or revision of the **COP**.

1.2 It is recommended that the employer*s* should, after consultation with the employees in terms of the **MHSA**, appoint a committee responsible for drafting the **COP**.

4.3 The **COP** must not be an overly technical **rock engineering** document and the participation of supervisory and employee level personnel, when compiling the document, is essential.

4.4 The members of the drafting committee, assisting the employer in drawing up the **COP,** must be listed giving their full names, designations, affiliations, professional qualifications and experience. This committee should include persons competent in **rock engineering** sufficient in number effectively to draft the **COP**.

5. GENERAL INFORMATION

Relevant information relating to the mine must be stated in this paragraph. The following minimum information must be provided -

5.1 Locality

A brief description and locality map to indicate the location of the mine in relation to towns, existing infrastructure and any other relevant features such as mines sharing a common boundary, dams, rivers and any other topographical features which could influence the strategies adopted.

5.2 Geological Setting

Geological structures, such as faults and dykes and stratigraphy, around individual coal seams must be described and any hazardous conditions highlighted. A typical geological section of the mine must also be included. A detailed geological assessment may not be necessary but a map showing major geological features in relation to mining outlines and shafts must be included.

5.3 Mining environment

The mining environment describes major subdivisions of coal seams, which dictates specific fundamental extraction strategies and occurs on a regional scale thus crossing mine boundaries.

Under this section the following information must be provided:

1.1.1 Coal seams mined:

A general description of coal seams being mined, including any relevant information such as average and range of mining depth, seam width/thickness, must be given.

1.1.2 **Regional Hydrology:**

The regional hydrology such as the occurrence of any significant groundwater and/or any other relevant information must be described.

5.4 **Ground Control Districts**

5.4.1 The location and extent of **ground control districts** must clearly be described in the **COP**. The nature of the virgin stress field in which mining is to take place, as well as the occurrence of significant pore water and any other local geological features, must be included here.

5.4.2 All **ground control districts** must be indicated on a **ground control district plan**, which must be kept in an office designated for that purpose by the employer.

5.5 **Mine Roof Fall Incident Analysis**

5.5.1 The **COP** must contain a tabulation of the mine's five year history of roof-related casualties (fatals, reportables and disabling incidents) and non-casualty incidents (where available), categorised according to **roof falls** per 1000 employees at work for both surface and underground operations.

5.5.2 This information must be graphically represented depicting annual statistics to facilitate easy interpretation of the data and to highlight trends

5.5.3 The **COP** must reflect the incident trend associated with the identified **hazards**. From this information the risk associated with each **hazard** can be established. These statistics should be normalised with respect to production tonnage in the different **ground control districts**.

6. TERMS AND DEFINITIONS

Any word, phrase or term of which the meaning is not absolutely clear or which will have a specific meaning assigned to it in the **COP**, must be clearly defined. Existing and/or known definitions should be used as far as possible. The drafting committee should avoid jargon and abbreviations that are not in common use or that have not been defined. The definitions section should also include acronyms and technical terms used.

7. RISK MANAGEMENT

1.1 Section 11 of the **MHSA** requires the employer to identify **hazards**, assess the health and safety **risks** to which employees may be exposed while they are at work and record the significant **hazards** identified and **risk** assessed. The **COP** must address how the significant **risks** identified in the **risk** assessment process must be dealt with, having regard to the requirement of section 11(2) and (3) that, as far as reasonably practicable, attempts should first be made to eliminate the **risk**, thereafter to control the risk at source, thereafter to minimize the **risk** and thereafter, insofar as the **risk** remains, to provide

personal protective equipment and to institute a programme to monitor the **risk**.

1.2 To assist the employer with the **hazard** identification and **risk** assessment, all possible relevant information such as accident statistics, research reports, various geological, hydrological, seismological information and geotechnical parameters or rock excavation processes must be considered.

1.3 In addition to the periodic review required by section 11(4) of the **MHSA**, the **COP** should be reviewed and updated after every serious incident or accident relating to the topic covered in the **COP**, or if significant changes are introduced to procedures, mining and ventilation layouts, mining methods, plant or equipment and material.

8. ASPECTS TO BE ADDRESSED IN THE MANDATORY COP

The **COP** must set out how the significant **risks**, identified and assessed in terms of the **risk** assessment process referred to in paragraph 7.1**,** will be addressed. Unless there is no significant **risk** associated with that aspect at the mine, the **COP** must cover at least the aspects set out below.

8.1 Strategies: Overall Mine Stability

The **COP** must give a description of the measures to-

- ensure the overall stability of a mine, which must include appropriate **rock engineering** input and measures to avoid catastrophic accidents;
- ensure the overall mining method and sequencing determined by the employer are followed;
- ensure that **support** design methodologies are properly motivated and documented;
- ensure the correct selection, use and maintenance of the equipment in **support** operations;
- avoid uncontrolled collapses of the mine or portion/s thereof;
- minimise the effects of the mining methods employed on surface structures and topography;
- ensure appropriate methodology and criteria are used for the design of in-panel and inter panel **pillars**.

8.2 Strategies: Protection of Mine Accesses/Exits

The **COP** must give a description of the following:

- a summary of the **rock-engineering** appraisal of the current stability of mine access/exit;

- measures to monitor ground movement;

- measures to protect employees against the **risks** associated with instability of access/exit ways;

8.3 **Strategies: Stability of Current Underground Workings**

The **COP** must give a description of the measures to-

- combat significant **risks** in bord and service excavations covering at least the following:
    - damage to the roof, floors and ribsides resulting from coal winning processes;
    - poor strata or mining conditions caused by geological features;
    - high or changing stress conditions; and
    - proximity to other workings;
- ensure that the excavation process and sequence for all roof brushing are appropriate;
- ensure the safety of personnel working and/or travelling as well as the opening-up and re-supporting in travelling and roadways.

ANNEX 1 sets out guidelines for bord and roadway excavation **support** strategy and is appended for information purposes only.

8.4 **Strategies: Coal Winning**

The **COP** must give a description of the measures to-

- address conditions such as loose rock and coal arising from stress changes or blasting, **support**, undercutting and **pillar** removal or face advance;
- ensure proper panel design methodology to accommodate the conditions expected for the different geotechnical setting;
- ensure proper **support** design methodology for each geotechnical setting applicable to bord and **pillar** workings and high/total extraction mining.

8.5 **Strategies: Hazardous Locations**

The **COP** must give a description of:

- conditions leading to the designation and classification of areas with significant **risk** of **roof falls** as **"hazardous locations"**;

- additional/special attention and precautionary measures;

- measures to effect rapid modifications to processes and/or procedures should such action require urgent review, and

- the role and responsibility of the competent person referred to in regulation 14.1(8) in the management of such **"hazardous locations"**.

ANNEX 2 deals with Strata Management in **Hazardous Locations** and sets out guidelines for special **support** strategies (This annex is for information purposes only).

8.6. **Strategies: Rock-Development**

The **COP** must give a description of the measures to minimise blast-induced damage to the roofs, floors and ribsides of excavations in hard-rock covering at least the following:

- drilling patterns and accuracy of drill holes;

- selecting and application of explosives and accessories to the conditions prevailing in different **ground control districts**;

- method and sequence of initiation of explosive charges.

8.7 **The Impact of Mining Activities on Neighbouring Mines**

The **COP** must give a description of the measures that will ensure that neighbouring mines exchange relevant information where the possibility exists that one mine's activities may have a significant impact on the activities of an adjacent mine, covering at least the following:

- rock developing methods, coal winning processes, methodology, techniques, sequence, excavation speed;

- regional **support**;

- prevailing common geological features/regime;

- percentage extraction of mineral resources/reserves;

- the timing and overall sequencing of mining operations with special emphasis on the removal of the boundary **pillars** separating adjacent mines.

8.8 **Monitoring of Ground Stability - Related Hazards/Risks**

The **COP** must give a description of the measures to determine the stability of the workings, covering at least the following:

- monitoring of roofs, floors and ribsides in the workings;
- identification and recording of significant geological discontinuities such as faults, slips, brows, intrusions, etc.

8.9 **Integrated Mine Process Design and Planning**

The **COP** must give a description of the measures for integrating the management of falls of ground related **risks** into the overall mine planning process. This should include the role of all individuals, the recording and archiving of all decisions and the execution procedure.

8.10 **Rock Engineering Support Service**

The **COP** must give a description of the measures to ensure that a competent person referred to in regulation 14.1(8) provides the relevant **rock engineering** inputs.

ANNEX 3 attached hereto sets out those aspects on which person competent in **rock engineering** referred to in Regulation 14.1(8) should provide input. (This annex is for information purposes only).

8.11 **Rock Engineering Competence**

The **COP** must set out procedures to ensure:

- the appropriate level of **rock engineering** related competence of persons directly involved with the mining operations, and
- competency records are kept and made available at the mine.

PART D: IMPLEMENTATION OF THE COP

1. IMPLEMENTATION PLAN

1.1 The employer must prepare an implementation plan for its **COP** that makes provision for issues such as organisational structures, responsibilities of functionaries and programmes and schedules for the **COP** that will enable proper implementation of the **COP**. (A summary of, and a reference to, a comprehensive implementation plan may be included.)

1.2 Information may be graphically represented to facilitate easy interpretation of the data and to highlight trends for the purpose of **risk** assessment.

2. COMPLIANCE WITH THE COP

The employer must institute measures for monitoring and ensuring compliance with the **COP**.

3. ACCESS TO THE COP AND RELATED DOCUMENTS

3.1 The employer must ensure that a complete **COP** and related documents are kept readily available at the mine for examination by any affected person.

3.2 A registered trade union with members at the mine or where there is no such union, a health and safety representative on the mine, or if there is no health and safety representative, an employee representing the employees on the mine, must be provided with a copy on written request to the manager. A register must be kept of such persons or institutions with copies to facilitate updating of such copies.

3.3 The employer must ensure that all employees are fully conversant with those sections of the **COP** relevant to their respective areas of responsibility.

ANNEX 1

BORD AND PILLAR MINING DESIGN STRATEGY / ROADWAY SUPPORT STRATEGY / HIGH / TOTAL EXTRACTION PANEL DESIGN STRATEGY / SUBSIDENCE CONTROL

(For information only)

1. Introduction

Separate sections in the Codes of Practice should be drawn up for each **ground control district**. For each area, strategies for the following should be recorded.

(a) **Pillar** Design for Bord and **Pillar** Mining layouts;
(b) Roadway roof **support** strategy;
(c) Where applicable, high/total extraction panel and **pillar** design strategy;
(d) Where applicable, subsidence control measures;
(e) Communication of changes in ground conditions.

The dimensions of roof **support**, **pillar** sizes, etc. should be contained in the mine standards. The strategy statements in the **COP** should contain details of the methods, which are to be used to determine those dimensions.

2. Design Methodology

1.1 SIMCOL 814 Research Report

The Design Methodology for Coal Mines set out in SIMCOL 814 should be consulted when performing any mine design.

2.2 *Bord and pillar mining pillar design*

Pillars should be designed to suitable safety factors using the Salamon and Oravecz (1976) formula or any other formula with proven applicability. Safety factors should be specified for the following:

(a) Primary development;
(b) Secondary development; and
(c) Production panels.

In all cases cognisance should be taken of any structures, which exist or could be reasonably foreseen to be created on or in the overlying surface and such structures should be protected by designing **pillars** to the appropriate safety factors. Where the coal strength is known to be different from the average value of 7,2 MPa, which was derived by Salamon and Munro (1967), the locally applicable value should be used.

2.3 ***Roadway roof support design methodology***

Coal mining roofs can be broadly classified into three main types:

2.3.1 ***No systematic support required*** *(i.e. massive sandstone roof):*

Strong roof requiring no systematic **support** should be investigated for changes in lithology at monthly intervals and the strategy adapted where necessary.

2.3.2 ***Suspension type*** *(i.e. relatively thin layer of weak material overlain by stronger layer):*

Suspension type roofs should be supported by means of a suitable **support** system designed by a competent **rock engineering** practitioner. The design should be based on the weight of the weak material, multiplied by a suitable safety factor, balanced by the load bearing capacity of the **support** system. The load bearing capacity of the system should be determined by tests.

Attention should be given to potential failures between **support** components, the **support** of discontinuities and the pre-support protection measures (i.e. maximum drivage distance before **support** is installed, **temporary supports**, canopy protection and the time delay before installing **support**).

2.3.3 ***Beam creation type*** *(i.e. thick layer of weak material like shale, mudstone or laminated material).*

Where a thick, weak roof occurs, roof **support** should be placed in such a way that the shear stresses in the roof are countered. In this way an artificial beam will be created. Alternatively, prop **support** or long anchors to provide sufficient suspension resistance should be provided. This **support** should be designed by a competent **rock engineering** practitioner.

Attention should also be given to inter **support** element failures, the **support** of discontinuities and the pre-support protection measures (i.e. maximum drivage distance before **support** is installed, **temporary support**, canopy protection and the time delay before installing **support**).

2.3.4 ***Roof affected by abnormally high or low horizontal stress levels***

It is generally accepted that in a coal mine, the horizontal stress is at least as high as the vertical and in most cases, somewhat higher. This is the general situation catered for by several decades of experience. In some cases, the horizontal stress is elevated, especially in the vicinity of certain geological features. Where this is the case, any of the above roof types may be adversely affected and it will be necessary to stiffen the **support** system or to increase the suspending capacity of the system. Where this is a problem, it is recommended to use the stress mapping technique described by Chase and Mark (1988).

In certain other cases, the roof may be subjected to an abnormally low horizontal stress. Where this happens, the roof may be de-stabilised by a lack of clamping forces across discontinuities. Also in this case, a special design is called for.

*2.3.5 **Generic roof support requirements:***

(i) *Geological Discontinuities:*

Joints, slips, dykes and other geological discontinuities should receive priority attention. An effective, scientifically motivated, discontinuity **support** system or systems should be included, beginning with the **hazard** identification and **risk** assessment and covering all steps up to the final safe situation.

(ii) *Road width:*

The maximum tolerable road width is an integral part of roof **support**, be it a massive, strong roof or a thick, weak material.

In the absence of historical data, the maximum road width should be calculated with standard beam theory, taking account of the thickness of roof layers, the loading of the beam and the tensile strength of the roof material.

(iii) *Burnt coal:*

Special **support** rules making provision for extended area cover (e.g. wiremesh, shotcrete, etc.) should be called for in burnt coal areas. The maximum pre-support drivage distance in burnt coal should be included in the strategy.

(iv) *Ribside **support**:*

Where ribside spalling could pose a significant **risk** (due to depth, mining height, weak or burnt coal, etc.) a suitable ribside **support** strategy should be part of the roof **support** strategy.

(v) *Water and gas pressure*

In cases where gas or water pressure could pose a significant **risk**, suitable measures such as pressure relieving holes or additional **support** should be included in the roof **support** strategy.

(vi) A procedure to determine changes in roof condition should be specified.

2.4 High/total extraction panel and pillar design strategy

The strata control of high extraction coal mining is dominated by the behaviour of the overburden strata and **pillars**. Panel width should be designed to ensure that the overburden either fails or remains intact, and then **pillars** should be designed to cater for the predicted stress levels.

For instance, if it is decided to mine in such a manner that a dolerite sill in the overburden remains intact, then higher stress levels will develop in **pillars** thus extracted and this increased stress should be taken into account when sizing the **pillars**. The same is true for inter panel **pillars** and chain **pillars** in total extraction.

The decision, on whether to allow the overburden to fail or not, should be based on the significant **risk** associated with the following considerations:

- underground stress conditions
- surface control
- groundwater control, i.e. water influx into the mine and
- environmental considerations.

In the case of **pillar** extraction, the strategy should include the considerations on which the direction of pillar extraction is to be done (i.e. from high to lower stress side of the panel or based on the trends of geological discontinuities) and the method of extracting a **pillar** as well as the **support** rule (i.e. roofbolt or timber breaker lines).

The panel and pillar design for high/total extraction mining should be done by a competent **rock engineering** practitioner. In the case where existing panels are considered for **pillar** extraction, a competent **rock engineering** practitioner should carry out an investigation.

Where partial pillar extraction is to be done, either by the complete removal of only certain **pillars** or by the partial removal of all or most of the **pillars**, cognisance has to be taken of the loading situation, which is determined by the panel width, mining depth, percentage extraction and the overburden stiffness. If not properly designed, this mining method may result in sudden failure of a large number of snooks. Partial **pillar** extraction methods should be designed for each individual case. Partial **pillar** extraction panels should be treated as **hazardous locations**.

2.5 Subsidence control:

In the case of high/total extraction mining or any other mining method, which could lead to subsidence of the surface, the strategy should include the treatment of the impacts of surface subsidence. This will require that surface subsidence be surveyed / monitored. Consideration should also be given to the consequences of rapid drainage of flooded areas.

The nature and magnitude of the subsidence should be predicted, followed by a prediction of the effects of the subsidence. This could include ponding, drying up of boreholes or cosmetic, architectural or structural damage to artificial structures.

The strategy should include a method of treating such impacts, for instance mitigation of ponds, compensation for crop losses, repair, replacement or abandonment of structures.

The subsidence prediction should include prediction of surface strains and tilts and be done using proven and established methods, either developed in a specific mining region or one of the more general methods like those of Schümann or van der Merwe.

3. References

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ANNEX 2

STRATA MANAGEMENT IN HAZARDOUS LOCATIONS
(For information only)

1. Description of hazardous locations

Any area which will require more stringent **support** than the normal **support** used on the mine, such as certain burnt coal areas, major dykes, multiple fault zones, etc., should be designated as a **hazardous location**. This designation allows management to make rapid modifications where it is required. The procedure for making the changes should be stated in the strategy.

1.1. Procedures for the declaration of hazardous locations

A procedure should be established which provides for:

(a) the identification of a **hazardous location** based on the hazard identification and risk assessment prescribed by the **MHSA**;
(b) the written notification to relevant personnel;
(c) the acknowledgement of receipt by personnel;
(d) the work place entry procedure;
(e) the **support** rule to be used; and
(f) a separate file for each working place classified as a **hazardous location** containing all relevant information regarding the classification, declaration procedure, and monitoring of that area.

To ensure the smooth operation of the entire procedure, the employer may appoint a Hazardous Location Officer in writing. The duties and responsibilities should be specified in the letter of appointment.

1.2 **Hazardous Locations** Committee

In order to review progress and co-ordinate general mine policy regarding the mining of **hazardous locations**, a Hazardous Locations Committee could be established, convened and meet on a needs driven basis.

The committee should comprise of senior mine management, a competent **rock engineering** practitioner and a representative from the Health and Safety Committee.

1.3 Functions of the Hazardous Locations Committee

The **COP** should specify the functions of the Hazardous Locations Committee.

2 Planning and Mine Design Function

2.1 The most suitable mining techniques and regional **support** for particular deposits are selected by applying **rock engineering** analysis to ensure that the desired

levels of stability will be maintained throughout the required period of operation The SIMCOL 814 Research Report (see the references at end of Annex 1) should be consulted.

2.2 Develop strategies for the **COP** after consultation with the mine's Health and Safety Committee.

2.3 Design or approve protection, control and **support pillars** on the mine.

2.4 Design service excavations to ensure stability throughout the excavation's active life.

2.5 Approve mining sequences to ensure that:-

- the factors affecting the stability of all excavations are taken into account;
- **support** systems (rules) to accommodate current and anticipated roof conditions are incorporated.

2.6 In bord and **pillar** workings:-

- select bord width based on sound **rock engineering** principles and design bord support systems (rules);
- a competent **rock engineering** practitioner referred to in regulation 14.1(8) checks the application of standard design techniques for correctness; and
- approve the design of **pillar** extraction operations taking **rock engineering** principles into account.

2.7 The competent **rock engineering** practitioner referred to in regulation 14.1(8) must provide input into mine planning or review meetings to ensure that the desired sequencing is adhered to and to answer any queries. Where significant departures from the planned layout occur, the competent **rock engineering** practitioner referred to in regulation 14.1(8) should ensure that variations do not create significant occupational health or safety **risks** to persons. Where necessary, he should indicate appropriate corrective actions required.

3 Routine Monitoring and Special Investigations

3.1 **Pillar** performance is regularly monitored to ensure that it conforms to design requirements.

3.2 Production and service workings are visited regularly to detect abnormal conditions and departures from planned layout.

3.3 Important chambers are inspected regularly during the excavation, to ensure adherence to the designed excavation sequence and **support** standard and sequence.

3.4 The performance of **support** systems in important excavations is monitored regularly.

3.5 Where a danger of instability exists in shaft or pit walls, regularly monitor displacements and, in particular, fault plane intersections.

3.6 Unusual ground conditions are investigated, findings reported, and remedial action recommended.

3.7 All roof-related fatal accidents are investigated and the accompanying **rock engineering** aspects of the official accident report completed.

3.8 All large or serious **roof falls** are inspected and an appropriate report is compiled.

3.9 Input is given on **risk** assessment matters pertaining to roof related issues.

4 Research And Technology Transfer

4.1 Staff should remain aware of new technological developments and actively pursue the introduction of those that can be gainfully employed on the mine.

4.2 Investigate, on an on-going basis, the possibility of improving existing **support** systems.

4.3 Update the mine's **COP** and related mine standards in consultation with the mine's Health and Safety Committee.

5 Quality Control

Routine quality control tests are supervised to ensure that **support** elements provide the required performance characteristics for the **support** design parameters.

6 Learning/Assessment

6.1 Assist with the provision of learning and assessment of underground personnel in strata control applicable to their mines, with particular emphasis on the identification of dangerous ground conditions.

6.2 Instruct learning facilitators in aspects of strata control.

ANNEX 3

THE ENVISAGED ROLE, FUNCTION AND CONTRIBUTION OF EFFECTIVE ROCK ENGINEERING SUPPORT SERVICE

(This annex to be used for information purposes only)

1. PURPOSE

The purpose of an efficacious Rock Engineering Support Service **(RESS)** is to assist the employer in ensuring that **rock mechanics** and strata control principles for the safe and economic design of mine workings is applied.

The **RESS** should assist the employer with the proactive identification of significant rock-related **hazards**/**risks** and to advice on appropriate measures to treat the same before persons are injured or workings damaged.

2. ENVISAGED BASIC SUPPORTIVE ROCK, FUNCTIONS AND DUTIES

To achieve the purpose of an efficacious **RESS**, the **RESS** should provide a basic supportive role, function and contribution as follows:

2.1 Participate in planning activities in order to identify and evaluate all layouts and face positions to determine any potentially dangerous or damaging situations created by, or likely to be created by, mining operations.

2.2 Review, identify and make recommendations to management with regard to systems, procedures and techniques employed by the mine to reduce or eliminate roof fall **hazards**.

2.3 Establish an efficacious monitoring, recording and reporting systems, which will ensure that relevant information is timeously provided to the correct people in planning and operating functions.

3. PARTICIPATION IRO PLANNING AND DESIGN ACTIVITIES

The **RESS** should participate/assist/make the following contributions to the rock excavation and design processes/activities:

3.1 assist with the design of rock excavation layouts, which will provide conditions conforming the requirements of affected relevant authorities with regard to surface structures.

3.2 design/propose efficacious mine **support** systems.

3.3 assist in the selection of the most appropriate rock development processes, techniques and accompanying regional **support** system for prevailing

conditions by applying best practice **rock-engineering** analysis to ensure that the desired level of stability of excavation are maintained throughout the required operations time horizon.

3.4 advise on effective **risk** management strategies to treat **significant roof-related hazards**/**risks**.

3.5 advise on the use of protection, control and **support pillars** at the mine.

3.6 advise on the location, shape, damage prevention measures and **support** of all tunnels and other service excavations to ensure stability throughout the excavation's active life.

3.7 evaluate and advise, as far as reasonably practicable, in respect of stone development processes, sequences and plans;

3.8 in board and **pillar** workings:

3.8.1 advise on the appropriate bord width in accordance with sound **rock engineering** principles and best practice as well as on the appropriate accompanying board **support** systems;

3.8.2 advise on the appropriateness and correct application of standardised rock excavation process planning and design techniques;

3.8.3 evaluate and advise in respect of the planning and design of high/total extraction processes in accordance with sound rock-engineering principles and best practice.

4 ROUTINE MONITORING AND SPECIAL INVESTIGATIONS

The following roles, assistance and inputs are envisaged for the **RESS** in respect of routine monitoring and special investigations;

4.1 regular investigations in the performance of panel **pillar**, roadway **pillars** and barrier **pillars** in high/total extraction mining:

4.2 regular monitoring of **pillar** performance to ensure that they conform to design requirements;

4.3 regular inspections of production and service workings to detect abnormal conditions and departures from planned layout;

4.4 regular inspections of important chambers during the excavation, to ensure adherence to the designed excavation sequence installation of **permanent support**;

4.5 regular monitoring of the performance of **support** systems in important excavations;

4.6 where a significant **risk** of instability exists in shaft, regular monitoring of displacements and, in particular, fault plane intersections;

4.7 investigation of unusual ground conditions, report findings and recommendations regarding remedial action;

4.8 appropriate participation in/assistance with the investigation of all roof fall-related fatal accidents, inclusive of the completion of the **rock engineering** aspects of the official accident report, and

4.9 inspection of all incidents of reportable falls of ground and submission of a report.

5. QUALITY ASSURANCE IRO SUPPORT SYSTEM/ELEMENTS

The **RESS** to advice the employer in respect of an effective quality assurance system for the **support** elements/system used at the mine.