

PRINCIPAL HAZARD MANAGEMENT PLAN (PHMP)

EXPLOSIONS

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1 Purpose

A safe and productive underground mine requires a detailed understanding of the processes involved in the operation of the mine and the effective control of the hazards and risks present within those processes.

The **GRO-1435-PLAN-Grosvenor Mine Overview Plan** (GMOP) provides context and background data on the mine's characteristic, its proposed mining operations and the identified Principal Hazards within those operations.

A series of Principal Hazard Management Plans have been developed in accordance with the requirements of the Coal Mining Safety and Health Act 1999 and its Regulation 2017, to ensure the operations at the Grosvenor Mine are conducted within acceptable levels of risk and that those risks are as low as reasonably achievable.

This Principal Hazard Management Plan [PHMP] aims to provide details of the processes, hazards, risks and effective control of **Explosions** as a principal hazard at the Grosvenor Mine.

2 Scope

This PHMP applies across the entire Grosvenor Mine operations and to all Coal Mine Workers at the mine.

3 Historical Context

3.1 Historical Context

Mine	Date	Outcome
Blakefield South	2011	Nil killed (55 men at risk) - Gas explosion and fire
Pike River	2010	29 men killed – Gas explosion
Moura No.2	1994	11 men died - Spontaneous Combustion resulting in Gas Explosion, and Secondary Explosion 2 days later
Moura No.4	1986	12 men died – Gas explosion
Appin	1979	14 men died – Gas explosion
Kianaga (Moura)	1975	13 men died – Spontaneous Combustion resulting in gas explosion
Box Flat (Ipswich)	1972	17 men died – Small fire started by Spontaneous Combustion developed into a major fire, resulting in an explosion

3.2 Explosion Principal Hazard Rules

- Always comply with NERZ/ERZ boundaries
- Always comply with UPEE procedure underground
- Always apply Stone dust to standard
- Always check your Cap Lamp before use, and report/tag damaged Cap Lamps

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- Always follow the Hot Work procedure when welding or cutting
- Always operate equipment in a manner that DOES NOT result in a frictional heat condition
- Do NOT operate a vehicle with defective/damaged electrical apparatus
- Do NOT use equipment that HAS NOT been authorised for use
- Do NOT bring contraband onto site
- Do NOT interfere with Gas Drainage infrastructure unless authorised
- Ensure auxiliary fans do not recirculate

4 Definitions

The following definitions are specific to this procedure.

Term	Definition
Critical Control	Critical Controls are controls that significantly influence the likelihood and/or consequence of an event (if removed, they will significantly impact the risk rating). Refer GRO-201-PRO-Risk Management
Critical Control Register	A register that documents the Critical Controls at the operation. It is a “live” document intended to record and communicate the current status of the effectiveness of the operation’s critical controls
Control Effectiveness	A matrix representation assigning an Effectiveness Rating on a control based on its Type as defined in the Hierarchy of Control and its Quality as measured by its Availability, Reliability and Survivability
Hazard	any energy that has the potential to do harm
Principal Hazard	a hazard at the coal mine with the potential to cause multiple fatalities [CMSHA Section 20]
Principal Hazard Management Plan (PHMP)	a documented plan to identify, analyse and assess risks associated with principal hazards, including the identification, analysis and assessment of the preventative and mitigation controls implemented to reduce those risks to acceptable levels e.g. Inrush PHMP
Risk	Risk means the risk of injury or illness to a person arising out of a hazard Risk is measured in terms of consequences and likelihood [CMSHA Section 18]
Risk and Control Register	a register that documents the identification and analysis of the processes, hazards and risks at an operation together with the identification and effectiveness analysis of the preventative and mitigation controls in place. It is a “live” document intended to record and communicate the current status of the <i>risk profile</i> and the <i>control profile</i> of the operation
Standard Operating Procedures (SOP)	a documented way of working, or an arrangement of facilities, at the coal mine to achieve an acceptable level of risk, developed after consultation with coal mine workers [CMSHA Section 14] The term SOP only applies to those procedures prescribed in the CMSHR 2017
First Action Response Plans (FARP)	a simple document that sets out the immediate steps required to be taken by those persons first on the scene at an incident
Trigger Action Response Plan (TARP)	a documented set of escalating actions that are to be taken in the event that certain criteria are met

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Term	Definition
Unwanted Event	An unwanted or unplanned release of energy resulting in, or with the potential to result in, harm to people, damage or loss to the operation

5 Principal Hazards and Risk Management

5.1 Hazard Inventory

The integrated operational risk management approach, as defined in the **Anglo American GTS02 Integrated Risk Management Standard** applied to the operations at the Grosvenor Mine has developed a comprehensive portfolio of process charts, hazard inventories and control strategies across the operation. The details of these hazards, risks and controls are contained in the site Safety and Health Management System.

5.2 Principal Hazard Identification

The rating of the potential consequences of the hazards contained in the site's hazard inventory, identified **Explosions** as a Principal Hazard with the potential to cause multiple fatalities.

5.3 Risk Assessment Methodology

All principal hazards at Grosvenor Mine are subjected to a detailed risk assessment using either a HAZOP or Bow-Tie methodology. Explosions was assessed using the Bow-Tie methodology involving the following steps:
Step 1

- A Fault Tree analysis to identify 'Causation and Release Mechanisms' together with a series of 'Preventative Controls' for the specific hazard. Refer **Figure 1 - Explosions Causation and Release Fault Tree**.
- An Event Tree analysis to identify the 'Consequences and Impacts' together with a series of 'Mitigation and Recovery Controls' to reduce harm should the hazard be realised. Refer **Figure 2 - Explosions Consequences and Impacts Event Tree**

Step 2

- The fault tree and event tree diagrams are then combined in a Bow-Tie spreadsheet where causes and consequences can be reviewed together and each control is analysed for its type, quality and effectiveness.
- In addition to control effectiveness ratings. Each causational and consequence group was risk rated using the Anglo American Operational Risk Matrix (as per **GRO-201-PRO-Risk Management**).

5.4 Fault and Event Trees

The abbreviated **Explosions Fault Tree** is presented in Figures 1. The abbreviated **Explosions Consequence Tree** is presented in Figure 2. Full versions of these Fault Trees and Event Tree are recorded in the site Safety & Health Management System.

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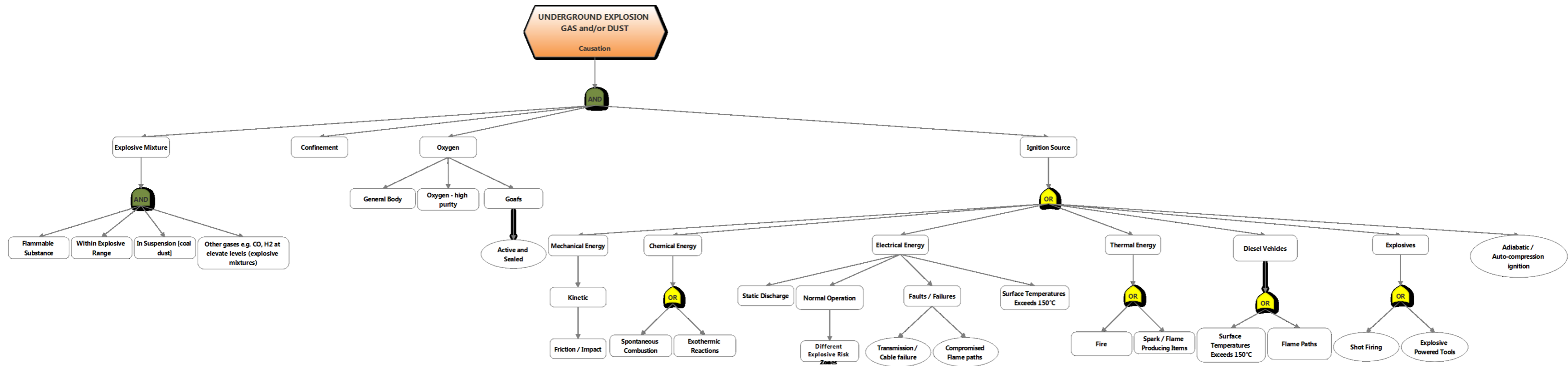


Figure 1 Explosions Causation and Release Fault Tree (abbreviated)

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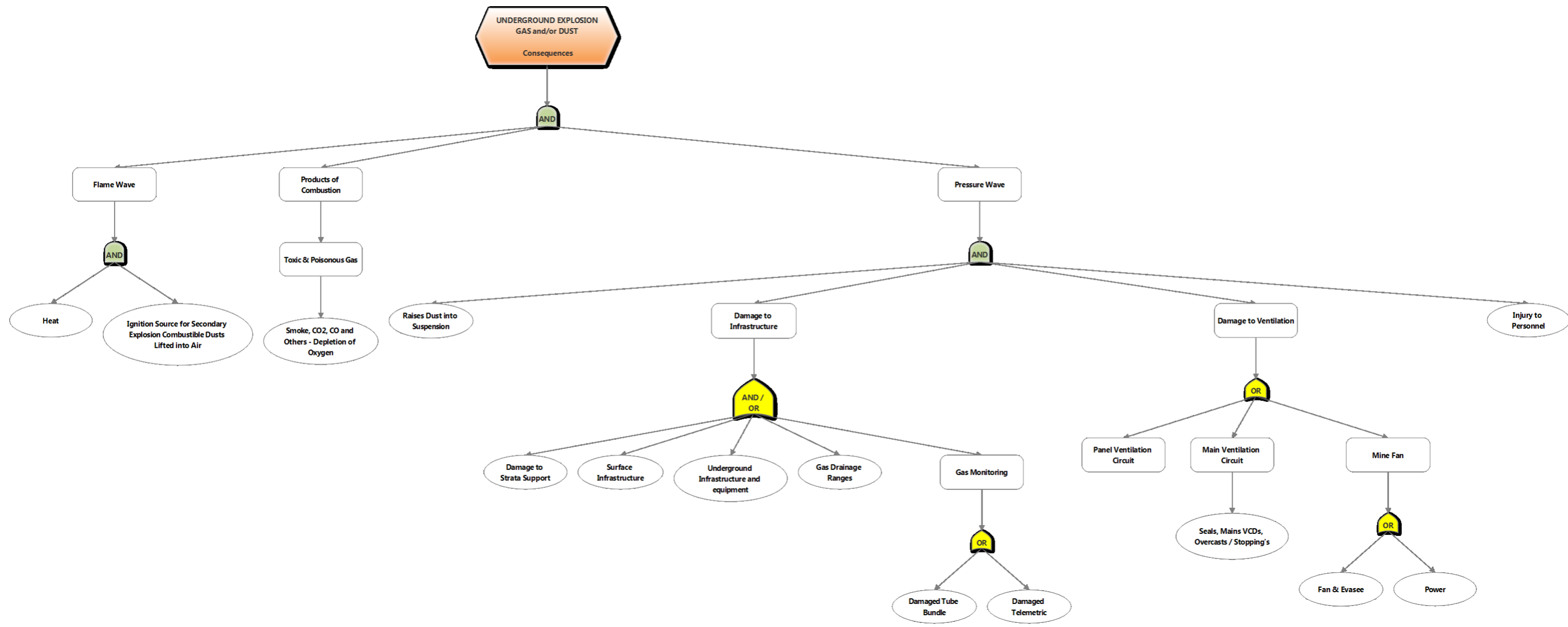


Figure 2 Explosions Consequences and Impacts Event Tree (abbreviated)

6 Control Management

6.1 Risk and Control Register

The **Risk and Critical Control Register** records those elements and resources for:

- The effective implementation of the **Preventative Critical Controls** identified in the fault tree for each cause and release mechanism, thereby providing a level of redundancy into the prevention of an unwanted event involving any principal hazard, and
- The effective implementation of the **Mitigation and Recovery Critical Controls** identified in the event tree for each potential consequence of an unwanted event, also providing a level of redundancy into the reduction of the consequences of the event and a return to normal operations as soon as possible.

The series of Preventative and Mitigation / Recovery controls are further expanded in the appropriate Principal Hazard Management Plans, Principal Control Management Plans, Trigger Action Response Plans, Standard Operating Procedures, Standard Work Instructions and other general procedures.

6.2 Grosvenor Safety & Health Management System

The elements of the **Grosvenor Safety & Health Management System** required to control risks associated with the Explosions principal hazard and the position responsible for that part of the system are listed in Table 1.

Table 1 Grosvenor Safety & Health Management System

Grosvenor Safety & Health Management System Element	Owner
Principal Hazard Management Plans	
GRO-16-PHMP-Methane Drainage	Underground Mine Manager
GRO-15-PHMP-Ventilation	Underground Mine Manager
GRO-14-PHMP-Gas Management	Technical Services Manager
GRO-10-PHMP-Spontaneous Combustion	Underground Mine Manager
GRO-5351-PHMP-UnderGround Fire	Underground Mine Manager
GRO-208-PRO Emergency Management Procedures	Underground Mine Manager
Standard Operating Procedures	
GRO-79-SOP-Contraband Underground	Underground Mine Manager
GRO-19-SOP-Explosives	Underground Mine Manager
GRO-59-SOP-Flammable Substances Underground	Underground Mine Manager
GRO-72-SOP-Aluminium Alloys Underground	Mechanical Engineering Manager
GRO-77-SOP-Underground Workplace Inspections	Underground Mine Manager
GRO-64-SOP-Using Portable Electrical Equipment Underground	Electrical Engineering Manager

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GRO-240-SOP-Fire Response & Control	Underground Mine Manager
GRO-18-SOP-Familiarisation with Using the Mine's Escapeways	Underground Mine Manager
GRO-20-SOP-Stone Dusting and Coal Dust Suppression	Underground Mine Manager
GRO-57-SOP-Mine Ventilation Control Devices	Technical Services Manager
Hazard Management Plans	
GRO-37-HMP-Underground Hot Work	Mechanical Engineering Manager
GRO-27-HMP-Location of Electrical Equipment Underground	Electrical Engineering Manager
GRO-29-HMP-Selection installation and use of cables and accessories	Electrical Engineering Manager
GRO-24-HMP-Provision for Self-Escape	Underground Mine Manager
GRO-22-HMP-Management and Maintenance of Self Rescuers	Underground Mine Manager
GRO-1463-HMP-Provision for Aided-Escape	Underground Mine Manager
GRO-42-HMP-Mine Inspection System	Underground Mine Manager
Trigger Action Response Plans	
GRO-750-TARP-General Body Contaminant.	Technical Services Manager
GRO-6953-TARP-Active Goaf Spontaneous Combustion	Technical Services Manager
GRO-1430-TARP- Goaf and UIS Gas Drainage Management	Technical Services Manager
GRO-3442-TARP-Evacuation Triggers for Underground	Underground Mine Manager
Other	
GRO-1629-PRO-Introduction of Underground Equipment	Mechanical Engineering Manager
GRO-204-PRO-Training Competence Scheme	Human Resources and Training Manager
GRO-3385-PRO-Permit to Mine	Technical Services Manager
Panel Standards	Operations Manager
Schedule of hazard and housekeeping inspections and audits	Operations Manager
Schedule of test and calibration of CO and methane monitors	Electrical Engineering Manager
Diesel equipment inspection, test and maintenance schedule	Mechanical Engineering Manager
Equipment pre-start checklists	Mechanical Engineering Manager
Electrical equipment inspection, test and maintenance schedule	Electrical Engineering Manager
Geological plan (locating all boreholes)	Technical Services Manager
Borehole Intersection Notice	Technical Services Manager

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6.3 Critical Control Management System

Those controls detailed in the Risk & Control Register as “critical” are managed through the site Critical Control Management System. Each Critical Control has two main components:

- an action or activity to execute the Critical Control, and
- an audit, inspection or monitoring activity to ensure that these Critical Control actions or activities are being conducted effectively

The actions or activity required to execute a critical control may form part a *Standard Operating Procedure*, *Hazard Management Plan*, *Safe Work Instructions* or some other form of *Work Control Method* mandated across the site.

The audit, inspection or monitoring activities required to ensure that these actions and activities are being conducted to the required standard, have been included as *Critical Control Audits* in the site Work Order Management System and/or the Enablon Risk Module.

This provides a level of assurance that all critical controls will remain effective, available and reliable for as long as the specific hazard exists at the site.

The recording and reporting of the outcomes of the Critical Control Audits are subject to regular and scheduled Senior Management Review.

Any actions generated as a result of the findings from the Critical Control Work Orders are entered into the site Action Tracking system (Enablon).

A summary of the Explosions Critical Controls associated with this Principal Hazard Management Plan can be obtained from the live Enablon database or through the SHE Department. A copy of the Critical Control register is updated monthly as part of the end of month process. This can be accessed on SHMS, ref to **GRO-9637-REG-Critical Control Register**.

7 Trigger Action Response Plans

Trigger Action Response Plans (TARPs) outline predetermined actions required to be taken in the event of a defined change in conditions or an escalation in the level of risk from the Principal Hazard. Defined Trigger Points describe indicators of the change in conditions or hazards and the mandatory actions required to be taken in response to those triggers. These Triggers and Responses are presented in a table for easy reading and are referenced to the PHMP.

There is no specific TARP for Explosions, however a number of TARPs in the SHMS would apply. These include but are not limited to:

- **GRO-750-TARP-General Body Contaminant**
- **GRO-6953-TARP-Active Goaf Spontaneous Combustion**
- **GRO-1430-TARP- Goaf and UIS Gas Drainage Management**
- **GRO-3442-TARP-Evacuation Triggers for Underground**

8 Resources

The resources required and the responsibilities to provide and maintain these resources are listed in Table 2 for Explosions.

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Table 2 PHMP Resources for Explosions

Resource	Responsibility
Gas drainage infrastructure	Gas Drainage Coordinator
Cutting equipment with pick lacing design and picks to minimise coal fines	Mechanical Engineering Manager
Water sprays to contain air borne dust from cutting face	Mechanical Engineering Manager
Conveyor design and water suppression to control dust generation	Mechanical Engineering Manager
ERZ NERZ boundary monitors set to trip power	Electrical Engineering Manager
Gas Monitoring System	Ventilation Officer
Machine mounted methane monitors set to trip power	Electrical Engineering Manager
Portable multi gas detectors	Electrical Engineering Manager
Designated storage facilities for cylinder gas, bulk fuel, oil and lubricants	Mechanical Engineering Manager
Designated diesel storage, transport and refuelling facilities	Mechanical Engineering Manager
Separate earth system for surface and underground	Electrical Engineering Manager
Electrical equipment certified for underground coal mine	Electrical Engineering Manager
Diesel engine systems compliant for underground coal mines	Mechanical Engineering Manager
Temperature monitoring and detection devices	Mechanical Engineering Manager
Fire and overpressure rated VCDs	Ventilation Officer
Reticulated fire water	Mechanical Engineering Manager
Fire Fighting equipment	Underground Mine Manager
Auto and manual fire suppression systems	Mechanical Engineering Manager
Designated underground escape ways	Underground Mine Manager
Self-escape facilities (cache, aids)	Underground Mine Manager
Designated places of safety equipped with communication	Underground Mine Manager
Self-contained breathing apparatus for self-escape	Underground Mine Manager
First aid facilities	Underground Mine Manager
Blast relief for fan	Underground Mine Manager
Entry sealing, airlock, emergency panel sealing and GAG facility	Underground Mine Manager
Back-up generator for fan	Mechanical Engineering Manager
FRAS non-metallic material	Mechanical Engineering Manager

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9 Communications

Information pertaining to this plan shall be communicated to all coal mine workers at the Grosvenor mine.

GRO-205-PRO-Communication, Consultation and Involvement.

10 Training & Competencies

Training shall be conducted in accordance with the **GRO-204-PRO-Training Scheme**. The training needs analysis and the Plan are to be mapped to those personnel with responsibilities under the Plan.

11 Corrective Actions Register

Corrective actions arising from the inspections, audits or incident investigations related to this plan shall be entered into the Mine Site Incident Management System or similar action tracking system.

12 Records

The records required to demonstrate implementation of this PHMP and the role responsible for maintaining them are listed in Table 3.

Table 3 PHMP Records for Explosions

Record	Responsibility
Hazard, housekeeping and workplace inspections	HSE Manager
Statutory inspections	Underground Mine Manager
Continuous telemetric and tube-bundle gas monitoring analysis	Ventilation Officer
Test and calibration results for all gas monitoring and detecting equipment	Electrical Engineering Manager
Introduction to site equipment inspections	Mechanical Engineering Manager/Electrical Engineering Manager
Equipment verification dossiers	Mechanical Engineering Manager/Electrical Engineering Manager
Equipment commissioning records	Mechanical Engineering Manager/Electrical Engineering Manager
Plant inspection, maintenance and test records	Mechanical Engineering Manager/Electrical Engineering Manager
Compliance hole gas content records	Technical Services Manager
Gas Drainage hole content records	Technical Services Manager
Firefighting equipment test and inspection records	Underground Mine Manager
Records of testing airlocks, seals and gag connection	Underground Mine Manager
Stone dust sampling and reapplication records	Underground Mine Manager

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Record	Responsibility
Records of inspection and test of self-contained breathing equipment	Underground Mine Manager
Earthing system for any surface to working connections	Electrical Engineering Manager
Goaf gas composition and trend analysis	Ventilation Officer
UPEE register	Electrical Engineering Manager
Light aluminium register	Mechanical Engineering Manager
Maintenance of fire/recue plans	Fire officer

13 Audit

The Plan shall be subject to a program of auditing to determine whether the mine activities conform to the Plan, and whether the arrangements in the Plan are adequate, implemented and effective. This program shall include:

- Internal critical control auditing scheduled on a yearly basis, and
- External auditing every 3 years (e.g. OMS, OCA and GTS auditing).

The audit findings shall be acted upon through the corrective action process and review mechanisms. Internal and external audits of the Plan will be identified in the Mine Audit Schedule.

14 Management Review

A review is an activity. In order to assure the ongoing effectiveness and continual improvement of this plan, the mine management shall undertake regular reviews to determine that the plan is capable of meeting its established objectives. These reviews shall be triggered in accordance with the criteria defined in the **GRO-206-PRO-Documentation and Data Control**, which includes:

- When a completed and authorised Change Management Process indicates that a review of documents is required. Refer to **GRO-200-PRO-Change Management**.
- When a hazard, defect or incident investigation recommends the review of a document(s).
- When a document owner requests a review.
- When a person who has an obligation under an act or regulation (pertinent to Grosvenor Mine), and has the authority to issue a directive requests the review.
- It falls due under a predetermined review timetable

15 Roles and Responsibilities

Responsibilities and accountabilities for the implementation and management of critical controls are located in the 'live' system (Enablon).

Specific responsibilities and accountabilities associated with the control of this principal hazard are defined in the Hazard Management Plans, Standard Operating Procedures and TARPS listed in the Grosvenor Safety & Health Management System Element table within this document.

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In addition, the Management Structure clearly defines the responsibilities and competencies required for senior positions in the structure that manage and control this Principal Hazard Management Plan.

16 Internal References

Internal documents referenced during the development of this plan were:

16.1 Grosvenor Coal Mine SHMS

- GRO-3600-RA-Explosions Bow Tie Analysis
- GRO-1435-PLAN-Grosvenor Mine Overview Plan
- GRO-201-PRO-Risk Management
- GRO-750-TARP-General Body Contaminant

16.2 Other internal reference

- AA GTS 02 Integrated Risk Management Standard
- AA GTG 02 Integrated Risk Management Standard: Guideline
- AA GTP 02 Risk Management Policy
- AA RP 02 242 Guideline for Conducting a Bow Tie Analysis

17 External References

External documents referenced during the development of this procedure were:

17.1 Legislation

- Coal Mining Safety and Health Act 1999.
- Coal Mining Safety and Health Regulation 2017.

17.2 Other references

- Anglo American Metallurgical Coal, Grosvenor Project, Fire Engineering Report dated 26 July 2012 H339205-5200-79-124-0001
- MDG 1032 Guideline for the prevention, early detection and suppression of fires in coal mines
- Riskgate (University of Queensland) 'Explosion Bow Tie Analysis'
- United Kingdom, HSE 'The prevention and control of fire and explosion in mines'
- Chief Inspectors Hazard Database - <http://mines.industry.qld.gov.au/safety-and-health/publications-guides.htm>

18 Amendments

Issue No.	Issue Date	Description	Initial
3	06/08/2015	Critical Controls Reviewed	JJ

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Issue No.	Issue Date	Description	Initial
4	04/12/2015	Critical control reviewed	RWL
5	02/02/2018	Revision of content, update to tables, document references and creation of internal audit tool. Post PHMP Bow-Tie Review (GRO-3600-RA-Explosions)	WW

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GROSVENOR COAL MINE

PHMP–Explosions

19 Appedix A: Internal Document Audit

AUDIT DATE:		AUDIT TIME:		AUDITOR/S:	
DEPARTMENT:		LOCATION:			
SPECIFIC TASK:				DOCUMENT OWNER:	

MEASUREMENT AND EVALUATION				
Measurement				Findings and Comments
1. Stone Dusting to reduce non-combustible matter. <ul style="list-style-type: none"> - Select a representative sample of completed roadway stone dusting reports and check the failure rate is within acceptable limits. - Has a designated person been appointed to manage stone dusting onsite e.g. Stone Dust Coordinator? If not, who is responsible for managing the stone dusting strategy and process? 				
Compliant <input type="checkbox"/>	Non Compliant <input type="checkbox"/>	Requires Improvement <input type="checkbox"/>	N/A <input type="checkbox"/>	
2. Effective water sprays on underground equipment (frictional heating and coal dust accumulation). <ul style="list-style-type: none"> - Validate how Grosvenor manages their dust suppression and water spray systems underground (longwall, development and conveyor systems). - Obtain a representative sample of maintenance records to confirm water spray systems are inspected and maintained in a fit for purpose condition. 				
Compliant <input type="checkbox"/>	Non Compliant <input type="checkbox"/>	Requires Improvement <input type="checkbox"/>	N/A <input type="checkbox"/>	
3. Elimination of explosive levels of gas. <ul style="list-style-type: none"> - Obtain and review the last 12 months of reportable gas limit exceedances to the Mines Department. From a trending perspective, what do the statistics show regarding failure rates and areas of concern? What control strategies have been implemented and are explosive levels of gas being effectively managed? 				
Compliant <input type="checkbox"/>	Non Compliant <input type="checkbox"/>	Requires Improvement <input type="checkbox"/>	N/A <input type="checkbox"/>	
4. A HMP has been developed and implemented for Frictional Ignition.				

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PHMP-Explosions

- Validate that the HMP is in place and current. Review the content in the HMP for quality, currency and alignment with the underpinning WRAC and Grosvenor’s operational control strategies for controlling frictional ignition.			
Compliant <input type="checkbox"/>	Non Compliant <input type="checkbox"/>	Requires Improvement <input type="checkbox"/>	N/A <input type="checkbox"/>

ACTIONS REQUIRED		ASSIGNED TO	DUE DATE	ENABLON TASK #
1				
2				
3				
4				
5				

AUDIT COMPLETED BY

Name Signature

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