PRINCIPAL HAZARD MANAGEMENT PLAN (PHMP)

GAS MANAGEMENT

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1. Introduction

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** 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 and other documented ways of working, 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 Grosvenor Mine are conducted at levels of risk that are within acceptable limits and as low as reasonably achievable.

1.1 Purpose

The provision of appropriate gas management has been identified through risk assessment processes as a control in the prevention and mitigation of fires, explosions, spontaneous combustion, and toxic and irrespirable atmospheres.

This Principal Hazard Management Plan [PHMP] aims to provide details of the planning, design, operation, maintenance, change management, inspection, audit and review processes required for the ongoing effectiveness and efficiency of the gas management system at the Grosvenor Mine.

This Principle Hazard Management Plan meets the requirements of Section 63 of the Coal Mining Safety and Health Act 1999, and Section 149 of the Coal Mining Safety and Health Regulations 2017.

2. Historical Context

Mine	Date	Outcome
Blakefield South	**2011**	**Nil killed -** 55 men at risk from gas explosion and fire
Pike River	**2010**	**29 men killed** – Gas explosion
Moura #2	**1994**	**11 men killed** - Spontaneous combustion in a goaf, sealing of the panel resulted in the goaf gas mixture entering the explosive range, resulting in a gas explosion. Secondary explosion nearly 2 days later.
Moura #4	**1986**	**12 men killed** – Roof fall in the goaf pushed methane into the working area including around a deputy's oil flame safety lamp, a significant gas explosion occurred.
Appin	**1979**	**14 men killed** – Gas explosion following a planned ventilation change

Kianga (Moura)	**1975**	**13 men killed** - Spontaneous combustion in a goaf. Sealing of the panel resulted in an explosion.
Box Flat (Ipswich)	**1972**	**17 men killed** - Small fire started by Spontaneous Combustion, developed into a major fire.

2.1 Region Overview

Coal seam gas in Australia is primarily composed of Methane CH_4 and Carbon Dioxide CO_2. The gas composition of the target mining seam at Grosvenor (Goonyella Middle Seam) is primarily methane. Higher alkanes (ethane) and nitrogen can also be present in minor proportions. Coal and methane are formed together during the coalification process, but can also be generated by bacteria.

Provision and maintenance of the systems and processes that support appropriate gas management control is fundamental to the management of a number of identified hazards inherent in the underground coal mining process, in particular;

- Asphyxiating or oxygen depleted atmospheres
- Toxic gases
- Flammable gases
- Frictional ignition

The gas monitoring system is required to operate with the ventilation and gas drainage activities at a mine to provide a safe environment. Legislation provides for a significant quantity of the site requirements for operations in regards to gas management, namely:

- NERZ / ERZ zoning for the mine
- Gas monitoring requirements locations, timing and mandatory action to be taken

The gas management system is part of a holistic management approach to these hazards to ensure that an acceptable level of risk is maintained. In particular, with the simultaneous management of seam gas emission, appropriate ventilation and spontaneous combustion.

2.2 Gas content

With the exception of the inbye half of the mine plan (Teviot Brook area), the gas reservoir database for Grosvenor is extensive for the P and GM seams. From testing undertaken to date, the composition of all seams is predominately CH_4 with compositions ranging from 97% to 100%.

The gas parameters for the P seam are:

- Measured virgin gas content varies from $6.5m^3/t$ to $11.5m^3/t$ at seam ash content.
- Measured permeability ranges from 264mD at a depth of 157m to 0.7mD at 389m.
- Calculated gas reservoir size ranges from $40m^3/m^2$ to about $80m^3/m^2$.

The gas parameters for the GM seam are:

- Measured virgin gas content varies from 5.2m³/t to 11m³/t at seam ash content.
- Measured permeability ranges from 225mD at a depth of 219m to 1.5mD at 404m.
- Calculated gas reservoir size ranges from 41m³/m² at MG1 entry to about 115m³/m² in the deeper north-eastern areas of the mine plan.

2.2.1 Gas Reservoir at the Time of Mining

The mining schedule will progressively impact the gas production wells of Arrow Energy. The timing of these impacts have been assessed on the flow rates and remaining gas for each well at the time of intersection. Gas content at the time of mining has been calculated to be between 3 and 7 m³/t in the P seam as shown in Error! Reference source not found. and from 2 to 10 m³/t in the GM seam as shown in Error! Reference source not found., indicating the necessity to implement an additional pre-drainage program(s) for outburst mitigation ahead of mining in the GM seam, in addition to establishing residual gas contents at levels low enough to not constrain longwall production rates .

Reservoir modelling simulating gas emission rates during mining incorporating the remaining gas content estimations (before additional pre-drainage programs), indicate the intake CH_4 concentrations will exceed legislative limits at planned ventilation quantities and panel advance rates during the development of inbye gateroads. This modelling work confirmed the need for further methane drainage at the mine.

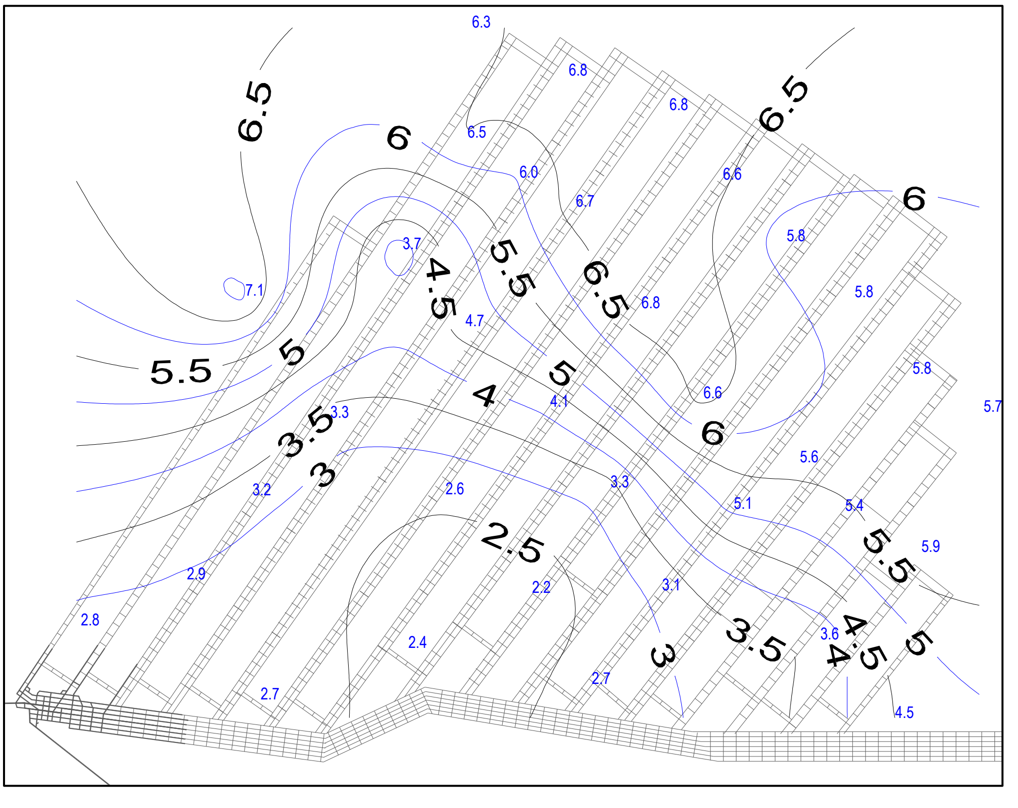

Figure 1 Gas Content at the Time of Mining – P Seam (Qm, m3/t @ seam ash) – without further drainage

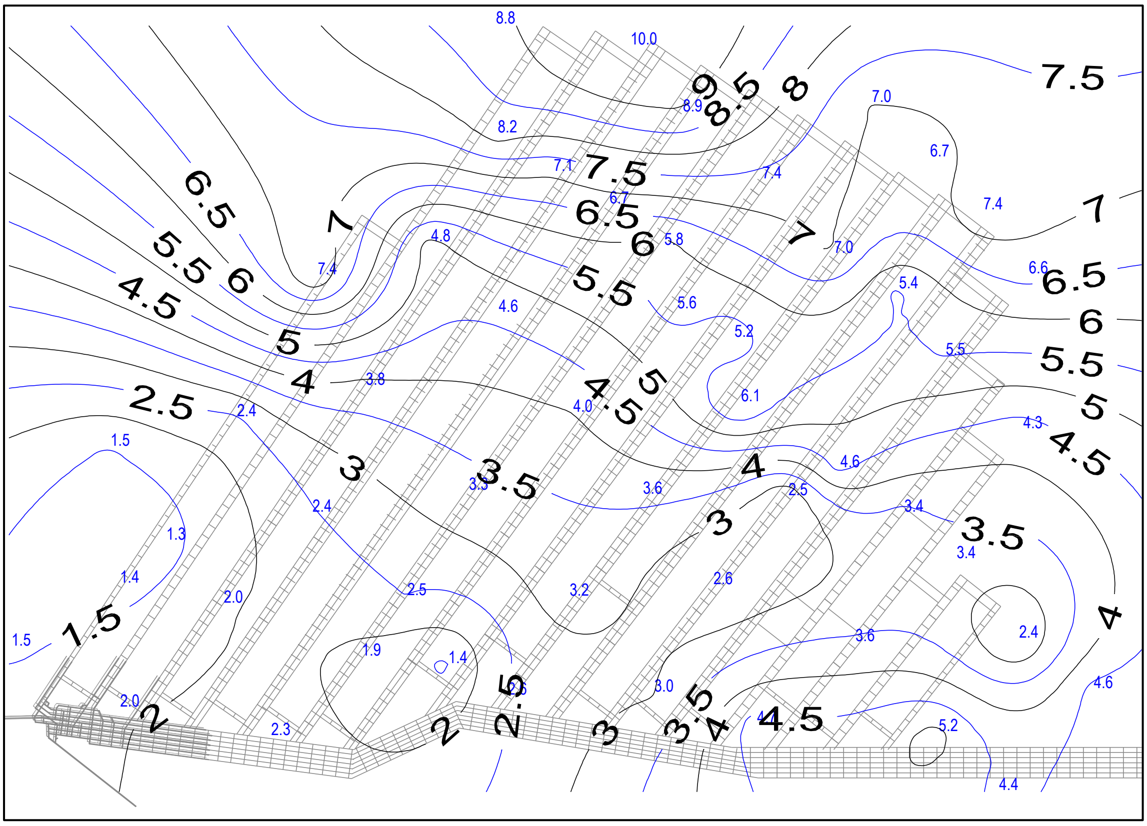

Figure 2 Gas Content at the Time of Mining – GM Seam (Qm, m3/t @ seam ash) – without further drainage

2.3 Scope

This PHMP applies to the Grosvenor Mine and to all persons working at the underground mine including surface to seam infrastructure connections including associated seam gas drainage activities on the surface.

2.4 Definitions

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

Term	Definition
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
Gas Database	A database of information developed and maintained by the Technical Services Department, which can be used as a tool for analysing potential gas hazards.
Hazard	any energy that has the potential to do harm
Predictive Model	A model based on historical and current data developed and maintained by the Technical Services Department which can be used as a predictive tool with respect to future potential gas hazards at the mine
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 controls implemented to reduce the risks to acceptable levels e.g. Fire 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 *risk profile* and the *control profile* 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 applies to those procedures prescribed in the CMSHR 2017
Trigger Action Response Plan (TARP)	a documented set of planned escalating actions that are to be taken in the event that certain criteria are met
Ventilation	The creation or existence of a pressure differential, which results in a movement of air and gas within the mine.
Ventilation Officer	Person appointed in accordance with s.61 of the CMSHA.

3. Principal Hazards Inventory

3.1 Hazard Inventory

The integrated operational risk management approach, as defined in the ***Anglo American GTS02 Integrated Risk Management Standard*** applied to the operations at Grosvenor Mine which 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.

3.2 Principal Hazard Identification

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

3.3 Risk Assessment Methodology

All principal hazards at Grosvenor Mine are subjected to a detailed risk assessment using either a HAZOP or Bow-Tie methodology. Gas Management was assessed using the HAZOP methodology involving the following process.

The underpinning Risk Assessment HAZOPS for this management plan was reviewed 13 September and 31 October 2017 and is titled ***GRO-5444-RA-Gas Management***. It details the-

- Intended / Normal Behaviour of the gas management plans
- Potential Deviations from those intended behaviours
- Release Mechanisms and Credible Causes for the deviations
- Consequences of the deviations
- Preventative Controls to reduce the Likelihood of such deviations
- Mitigation / Recovery Controls to reduce the consequences of such deviations
- Control Effectiveness Analysis
- Risk Ratings; and
- Any identified further actions / improvements

These Preventative and Mitigation controls are documented in the site Risk and Control Registers (electronic database – Enablon) and implemented through the range of documented procedures, management plans and training schemes at site.

3.4 Operational Performance Criteria

Table 1 Gas Management [Monitoring] System: Operational Performance Criteria

Criteria	Telemetric / Real-time	Tube Bundle
Sampling	CO - product of combustion [0-50ppm] CH4 [0-5%] O2 [0-21%] CO2 [0-5%]	IR Analysers- High Range CO - product of combustion [0-1000ppm] CH4 [0-100%] O2 [0 - 21%] CO2 [0-50%] Low Range Analysers provide data from Ventilation Air Monitoring [VAM]of CH4 and CO2 for National Greenhouse Emissions Reporting Scheme [NGERS]
Locations	- General Body Atmosphere monitoring as defined by Regulation Part 7 Division 1 s221-226 Grosvenor: Intakes, Conveyor Tail Ends, returns of all ventilation splits, return side of all seals located in intake airways, NERZ-ERZ1 boundaries, main fan installation, active gas stubs, electrical equipment installed on return side of intake passing seals, permanent underground fuel depots	- Atmosphere monitoring as defined by Regulation Part 7 Division 1 s221-226 Grosvenor: returns of Longwall ventilation splits, behind permanent seals, sealed areas, active longwalls goafs, bottom of up-cast shafts
Analysis, Data Manipulation, Calculating, Trending etc.	- Version controlled SafeGas and CITECT software - Installed and maintained in compliance with Corporate IT Standards, security and controls	- Version controlled SafeGas and CITECT software - Installed and maintained in compliance with Corporate IT Standards, security and controls

Criteria	Telemetric / Real-time	Tube Bundle
Visual Alarms	- Control Room - At the instrument underground - CITECT screens across the network Audio alarms: In control room via gas monitoring system	- Control Room - CITECT screens across the network Audio alarms: In the control room via the gas monitoring system
Supervisory Control and Data Acquisition system SCADA	- Surface Server Rooms - Multiply-redundant fibre optic communication systems - Wireless Ethernet protocols - Client-Server Architecture - Off site Back-Ups and Data Storage	- Surface Tube Bundle Huts connected to Client Server network - Multiply-redundant fibre optic communication systems - Wireless Ethernet protocols - Client-Server Architecture - Off site Back-Ups and Data Storage
Displaying	Multiple screens across site, including underground displaying CITECT output screens	Multiple screens across site, including underground displaying CITECT output screens
Contingency	- Client-Server systems have back-up diesel generators and UPS systems	- All Gas Monitoring huts and infrastructure will have back-up diesel generators and UPS systems when commissioned - Client-Server systems have back-up diesel generators and UPS systems
Provision for Repair / Maintenance	- Telemetric systems can be isolated for maintenance & calibration [prevent false alarms, trips] - Portable hand held Gas Detectors for use if gas monitoring system down either by failure and/or maintenance	- Tube Bundle systems can be isolated for maintenance & calibration [prevent false alarms, trips] - Portable hand held Gas Detectors for use if gas monitoring system down either by failure and/or maintenance

Criteria	Telemetric / Real-time	Tube Bundle
Redundancies	Separate systems for 1 NERZ / ERZ Monitoring 2. Environmental monitoring systems 3. Tube Bundle Huts 4. Real time gas monitoring on fixed plant [CH4 on machines, CO on conveyors]	Separate systems for 1 NERZ / ERZ Monitoring 2. Environmental monitoring systems 3. Three Tube Bundle Huts 4. Real time gas monitoring on fixed plant [CH4 on machines, CO on conveyors]
Alarm Set points and ratios	- Set by the Ventilation Officer in consideration of circumstances and historical information, relevant to the environment, mining conditions and risk-based TARPs at the time. - All changes subject to Documented Authorisation and Sign-Off - All alarm settings displayed for ease of reference - Gas plant alarm set points in consultation with VO	- Set by the Ventilation Officer in consideration of circumstances and historical information, relevant to the environment, mining conditions and risk-based TARPs at the time. - All changes subject to Documented Authorisation and Sign-Off - All alarm settings displayed for ease of reference

4. Gas Management System

4.1 Planning

Gas management planning for Grosvenor Mine forms part of and is controlled by the general mine planning annual cycle.

Three plans must be reviewed and updated as required, i.e.

- Long term plan (strategic plan + 5 year time frame);
- Medium term plan (1 year MOP outlook);
- Short term plan (90 Day MOP planning).

While the planning process remains fundamentally unchanged for each different level of plan, the detail and effort must increase as the time frame for the plan shortens.

As a minimum each plan must contain:

- Virgin gas content predictions;
- Gas drainage strategies (Arrow Energy + Anglo);
- Post-drainage gas emission predictions (rib emissions and face emissions for development and specific emissions for longwall panels);
- Minimum ventilation airflows to dilute the predicted gas levels;
- Goaf drainage strategies;
- Predicted greenhouse gas emissions.

Short term plans must also include mine layouts showing the location of gas monitoring points (both telemetric gas detectors and tube bundle sample points) during the life of the plan plus a schedule showing the approximate timing for any changes or relocation of monitoring locations.

4.2 Computer Models

A computer model of the ventilation system using commercial software must be maintained at the Grosvenor Mine.

The commercial software selected for the mine ventilation model should be compatible with software used at other sites in Queensland but in any case the software must be capable of simulating airborne contaminant distributions underground.

The computer model must be updated every month and following any ventilation change and the most recent model should be used for gas management planning.

4.3 Design

4.3.1 Design Targets

Pre and Post-Drainage programs shall be designed and implemented where possible to strive to achieve the design targets for Development and subsequent Longwall mining.

First and Second workings gas content targets:

- Development mining – gas content < 4 m^3/t CH_4;
- Longwall extraction – gas content < 2 m^3/t CH_4 for working seam and specific emission levels assessed on a block by block basis

Goaf drainage targets:

- Flow per goaf hole > 500l/s at nominated methane composition;
- Suction pressure at goaf hole collars > 5 kPa;
- Holes on suction > 4;
- Methane concentrations of > 60% (Minimum allowable gas concentrations shall be stipulated in associated TARP's for active goaf spontaneous combustion management and goaf well management).

Underground roadway gas composition design targets are required to minimise gas or ventilation impacts to production activities and are inherently related to achieving the pre/post drainage targets. Trigger levels for gas in roadways are stipulated in **GRO-TARP-750-General Body Contaminant**.

Methane (CH_4) targets in ventilation circuit:

- Longwall tailgate < 1.25%;
- Development panel returns < 1%;
- NERZ / ERZ1 boundaries < 0.3%;
- Upcast shaft < 0.5%;

NOTE: Situations may arise when it may not be necessary to achieve the design targets detailed above. The Permit to Mine process along with the relevant TARP's will be utilised in these circumstances to help achieve safe and efficient mining.

4.3.2 Design Process

All gas management designs must use the most recent:

- In-situ (residual) gas compliance cores and where unavailable virgin gas content predictions from exploration;
- Drilling program and extracted gas estimates from Arrow Energy;
- Other available gas drainage information (e.g. site gas drainage programs);

Post drainage panel rib emission estimates should be based on previous measurements at Grosvenor or if no measurements are available the original GeoGas estimate of at most 300Ltr/sec CH_4.

Longwall specific emission estimates should be based on the most recent data set for Grosvenor and reconciled with the Flugge method using 54° for roof coal contributions and 22.5° for floor coal contributions with post drainage gas content estimates for the relevant seams, i.e.

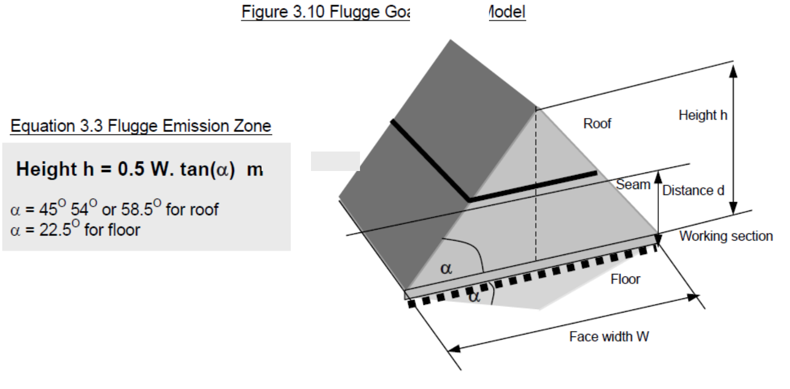

Figure 3 Flugge Method

Gas management design should target <1% CH_4 in the panel return and the goaf drainage system should be designed to remove the specific emissions expected from overlying and underlying seams.

All proposed designs must consider:

- Implementation issues (risks / hazards / difficulties);
- Outcomes achieved;
- Impact (if any) on:
    - Mine escape routes;
    - Spontaneous combustion potential;
    - Dust liberation (water will be drained from the seam with gas);
    - Sealing / inertinisation procedures;

- Sealed goafs (pressure balances); and

- Any risks or hazards introduced by the proposed design are to ensure all risks are as low as reasonably achievable;
- Controls for unwanted events (i.e. fires, explosions, toxic and irrespirable atmospheres, spontaneous combustion) to ensure the risks are as low as reasonably achievable;
- Whether the proposed change will interfere or impact on any other department or process;
- Whether the change management process is triggered by the proposed design or change;
- Implementation costs.

Final designs must be documented and communicated.

4.4 Atmospheric Monitoring

4.4.1 Atmospheric Monitoring Systems

The atmospheric monitoring system at Grosvenor Mine consists of a tube bundle system and real time (telemetric) transducers reporting data to several PCs. A gas chromatograph is also located in the surface control room and manned by persons trained in its use. These persons have access to external providers to assist with fault finding, calibration and interpretation on an as need basis.

The atmospheric monitoring system is designed to allow ongoing assessment of the status of the underground mine environment with regards to contaminant gases.

To assist in the monitoring of mine gases, and to manage the risk in the event of a failure or non-operation of the gas monitoring system, the underground maintains a sufficient number of portable gas monitors to be used by persons authorised and trained in their use.

Alarm levels for selected gas concentrations are detailed within the relevant TARPs. Alarm set points can only be set or changed in accordance with **GRO-62-SOP Changing gas alarm levels**. The original copy of all alarm set levels will be stored in the Master Gas Alarm Register and changed with **GRO-764-PMT Permit to Change or Relocate Mine Atmosphere Monitoring Device** or **GRO-6876-PMT-Permit to Change or Relocate Tube Bundle Monitoring Point.**

4.4.2 Telemetric Monitoring

The telemetric gas monitoring system is a specific set of monitoring devices, established to fulfil the obligations under the CMSHR 17 Sections 221A-226, 242-243 and 346.

The information is relayed to a local gas monitoring enclosure which provides local audio-visual alarming and also transmits the same information onto the site-wide IMAC gas guard (Ampcontrol) network.

Alarm levels are set per relevant TARPs of this Principal Hazard Management Plan, and will alarm in the Control Room, which is manned to acknowledge any alarms and respond appropriately. The Control Room Officer will respond to gas alarms as per **GRO-68-SOP Acknowledge Gas Alarms Underground**.

Uninterruptible Power Supplies (UPS) provide power to each sensor underground, the Safegas Server and the Control Room in the event of a power failure. Underground gas monitor installations are to be reviewed for IS compliance and anticipated UPS loading prior to energization.

The analysers have the ability to detect:

- Methane (CH4);
- Carbon Monoxide (CO);
- Carbon Dioxide (CO2); and
- Oxygen (O2).

The sensors are utilised as:

- Four-Gas (CH4, CO, CO2, O2) sensors in return airways;
- Methane sensors at ERZ Boundaries;
- Carbon Monoxide sensors on the return side of each conveyor belt;
- Four-Gas (CH4, CO, CO2, O2) on the return side of longwall seals over which intake air passes.

(The VO or the UMM may give authorisation for these to alarm locally only, taking Section 346 of the CMSHR 17 into consideration).

Any changes to the gas monitoring system must be approved by the Ventilation Officer:

For installation, relocation and removal of sensors, **GRO-764-PMT Permit to Change or Relocate Mine Atmosphere Monitoring Device**, **GRO-6876-PMT-Permit to Change or Relocate Tube Bundle Monitoring Point.**

Changes to the gas alarm levels shall be done in accordance with **GRO-62-SOP Changing gas alarm levels** and **GRO-764-PMT-Authority to Change or Relocate Real Time Sensor** to be completed.

In the event of a failure or the non-operation of the Gas Monitoring System, Portable Gas Detectors may be used to manage the risk. This will be done in accordance with **GRO-70-SOP Action to be Taken if a Methane Detector Activates or is Non-Operational** and **GRO-750-TARP-General Body Contaminant**.

4.4.3 Tube Bundle Monitoring

The tube bundle pumps, analysers and computer system are located in a surface building.

Tube lines run underground into the areas that require monitoring.

The tube bundle system has the capability to monitor multiple locations. Air samples are drawn by vacuum pumps located in the gas monitoring building continually from the mine via tubes to the surface. A sample of air from each tube line is then analysed sequentially.

The analysers have the capability to detect:

- Methane (CH_4);
- Carbon monoxide (CO);
- Carbon dioxide (CO_2); and
- Oxygen (O_2).

The underground location of the tube bundle monitoring points should include:

- Sealed goaf areas in the mine;
- Active goaf areas in the mine;
- Longwall return roadways;
- The base of an upcast shaft; and
- Any other points considered necessary by the VO or UMM.

The system also has the capability to draw samples from the underground monitoring points, and deliver to a gas bag. This gas bag can then be run through the Gas Chromatograph which analyses a wider range of gases. Also, if a bag sample is taken from the underground (general body sample or a seal without a Tube Bundle tube), then that sample can be analysed by the Tube Bundle Analyser.

Each tube is integrity tested as per AS2290.3 to check the accuracy of the sample. This is done in accordance with **GRO-5865-SWI Grosvenor Tube Bundle Integrity Test**.

No person shall interfere with any part of the tube bundle monitoring system without the authorisation of the Ventilation Officer.

4.4.4 Hand Held Gas Detectors

Hand held gas detectors must only be used by personnel authorised by the Underground Mine Manager.

Multi-gas detecting, handheld instruments are primarily used during statutory inspections by ERZ controllers. Sufficient units are provided such that each inspection zone is allocated with its own monitor to be used by the ERZ Controller, with additional monitors for other coal mine workers requirements.

Alarm settings on these instruments are outlined in Table 2 Hand Held Gas Detectors alarm settings.Table 2. The change of management process may be used if there is an operational requirement for alternative alarm settings.

Table 2 Hand Held Gas Detectors alarm settings.

	Altair 5X Units		Altair 4X Units		Altair 4X Units UPEE	
Gas	Low Alarm	High Alarm	Low Alarm	High Alarm	Low Alarm	High Alarm
Methane - CH_4	1%	1.25%	1%	1.25%	0.4%	0.5%
Carbon Monoxide - CO	15ppm	20ppm	15ppm	20ppm	15ppm	20ppm
Hydrogen Sulphide - H_2S	10ppm	15ppm	5ppm	10ppm	5ppm	10ppm
Oxygen - O_2	19.5%	22%	19.5%	22.0%	19.5%	22.0%
Nitrogen Dioxide - NO_2	2ppm	2.5ppm				
Carbon Dioxide – CO_2	0.5%	1.0%				

4.4.5 Gas Chromatography

Bag samples are routinely collected and analysed though the site gas chromatograph for;

- Hydrogen (H^2);
- Oxygen (O^2);
- Nitrogen (N^2);
- Methane (CH^4);
- Carbon Monoxide (CO);
- Carbon Dioxide (CO^2);
- Ethylene (C^2H^4); and
- Ethane (C^2H^6).

Data gathered using the gas chromatograph is entered into the Simtars Seamgas program for analysis and trending of data. The bag sample data should be routinely reviewed and hard copies of test results filed and countersigned as reviewed. The gas chromatograph is operated and maintained as per the Simtars OEM requirements.

4.4.6 Real Time Methane Sensors on Plant

Real time methane sensors are also used to protect plant powered by battery, electricity or internal combustion engine. The plant to be protected by these methane detectors are listed below:

- Auxiliary fans;
- Main exhaust fans;
- Continuous miners;
- Road headers;
- Longwall shearers;
- Mobile bolting machines;
- Explosion protected load haul dump vehicle powered by a battery or internal combustion engine;
- Other explosion protected plant powered by electricity, or an internal combustion engine; and
- Longwall Face equipment.

The alarm and trip set points are set as per their respective section in the CMSHR 17, or lower if designated by the Ventilation Officer or the Underground Mine Manager. Any equipment which a methane sensor is protecting must not be powered up underground unless its methane sensor is operational or **GRO-70-SOP Action to be Taken if a Methane Detector Activates or is Non-Operational** is followed.

4.4.7 Bag Sampling

The Ventilation Officer will issue a bag sample regime for samples to be taken on a regular basis. Bag samples will also be taken in line with TARP actions. Samples will be taken in accordance with **GRO-7440-SWI-Gas Bag Sampling Underground**. All samples will be analysed through the on-site gas chromatograph and recorded in the gas chromatograph (GC) Analysis Book.

The operation of the gas chromatograph will be in accordance with the Spontaneous Combustion Hazard Management Plan and SIMTARS operating procedures located in the gas chromatograph room.

A reciprocal agreement has been negotiated with Moranbah North Mine, such that in the event of a failure of either gas chromatograph, or a check on a sample is required, that a person will be made available to analyse the samples on the other gas chromatograph.

All full time Control Room Operators and the VO will be trained by the relevant OEM or other authorised training organisation on the use of the gas chromatograph. This will be formal training on the use and routine maintenance of the gas chromatograph.

Copies of trend analysis will be saved on the GC computer and hard copies placed in the Ventilation Record Files each quarter or as deemed necessary by the Mine Manager or VO.

4.4.8 Failure of Monitoring System

Failure of one or more monitoring points or systems (real time and tube bundle) will trigger the provisions of **GRO-68-SOP-Acknowledging Gas Alarms** and **GRO-71-SOP-General backup for gas Monitoring**

System. For methane monitors that are interlocked to trip the power **GRO-70-SOP Action to be Taken if a Methane Detector Activates or is Non-Operational** is used.

Where an individual monitoring point is identified by an ERZ Controller as being inoperative they will instigate manual readings at the site of the monitoring point as per **GRO-71-SOP-General backup for gas Monitoring System**. If the failure is in a tube line monitoring system within the goaf environment, a bag sample regime will be initiated until the point is operational again. The reading and the reason why the measurement was conducted will be recorded on their statutory report.

Where it is identified that a monitoring point has failed, that person will inform the Control Room Operator immediately. The Control Room Operator will inform the appropriate official, and it shall be their responsibility to initiate the appropriate response to implement a temporary monitoring program and have the sensor repaired and recalibrated.

4.4.9 Analysis and Interpretation of Data

All of the following gas monitoring data sources will be continually logged by Safegas;

- The real time gas monitoring system; and
- Tube bundle system.

Trend analysis of gas and ventilation monitoring data is conducted using the Safegas software. Safegas allows trending of monitoring results in the form of time based charts and viewing of the data in a report based format. Safegas also has the ability to produce both Coward and Ellicott Diagrams for a nominated tube bundle monitoring point. Several combustion indicator ratios are calculated for each monitoring point and these also can be trended.

The system automatically detects and calculates the values of:

- Gas concentrations;
- CO make;
- CO/O2 deficiency ratio (Graham's Ratio);
- CO/CO2 ratio; and
- Gas explosibility.

Alarm set points as described in Section 222(2)(b) of the CMSHR 17 are detailed within the relevant TARPs. The ratio and gas alarm levels are set by the Ventilation Officer and reviewed and set based on historical data and updated regularly.

4.4.10 Alarm Levels for Gas Concentrations and Ratios

Safegas alarm set points are defined as:

- High High Point values (HHPV);
- High Point Values (HPV);
- Low Point Values (LPV); and
- Low Low Point Values (LLPV).

Some alarm levels are aligned with specific TARPs. This section reinforces the TARP levels and gives direction on alarm levels for other set points. During the final stages of sealing a part of the mine, alarm levels for environmental monitoring on the return side of the part to be sealed may be set at the Ventilation Officer's discretion.

Some alarms particularly negative CO values are diagnostic alarms and alert the CRO and VO that the particular instrument needs calibrating.

Carbon Monoxide (CO)

The alarm set levels for carbon monoxide CO are detailed in the relevant TARPs. The CO alarms are based on CO ppm but this is calculated for many areas based on the CO make. Other ratios for the early detection of spontaneous combustion are also calculated by the Safegas system. These include:

- Graham's ratio;
- CO – CO_2 deficiency ratio;
- Morris' ratio;
- Tricketts; and
- Young's ratio.

Methane (CH4)

The alarm set levels for Methane CH_4 are dependent on their function and location. For example the function of a NERZ-NERZ or NERZ-ERZ1 point is to automatically trip the power if there is 0.5% CH_4 in the intake airway adjacent to electrical equipment. All alarm levels for CH_4 are detailed in the relevant TARPs.

Oxygen (O2)

The alarm set levels for oxygen O_2 are detailed in the relevant TARPs. General body oxygen alarms are for the purpose of identifying oxygen deficient atmospheres in roadways. Oxygen alarms in sealed areas are for the purpose of detecting leaking seals. If the seal leaks the outside atmosphere will be drawn into the sealed area as the barometer lowers and increase the oxygen content in the goaf. This can cause spontaneous combustion and the atmosphere to approach an explosive level if not properly managed.

The high point alarms are again used as diagnostic alarms to show that the instrument is out of calibration.

Carbon Dioxide (CO_2)

The alarm set levels for carbon monoxide CO_2 are detailed in the relevant TARPs.

4.4.11 Gas Ratios

Carbon Monoxide Make (CO Make)

CO make is the primary method of determining if a spontaneous combustion event exists. The establishment of Carbon Monoxide make involves calculation of the volumetric flow rate of Carbon Monoxide:

CO Make (l/min) = CO (ppm) x Airflow (m^3/s) x 0.06

GRO-6953-TARP-Active Goaf Spontaneous Combustion is used to determine the HPV and HHPV CO make alarm levels for real time and tube bundle monitoring in active longwall returns.

All CO make background levels will be reviewed every month as part of the monthly ventilation survey. Alarm levels will also be checked monthly and adjusted if necessary.

Carbon Monoxide/Oxygen deficiency ratio

The Carbon Monoxide/Oxygen deficiency ration is more commonly known as Graham's Ratio, which can be calculated using Equation 1:

$$GR = \frac{CO\ (\%) \times 100\%}{(0.265 \times N_2) - O_2} \qquad (1)$$

Where:

- GR = Grahams Ratio
- CO = Carbon Monoxide concentration
- N_2 = Nitrogen concentration
- O_2 = Oxygen concentration

The basis of this calculation is that the ratio of Oxygen to Nitrogen in normal atmospheric air is 0.265. This calculation becomes invalid if there is any Nitrogen enrichment of the atmosphere, such as during the use of an IGG. Also note that readings in a Longwall Tailgate will be indicative of all activity on the intake side of the sample point.

- < 0.4 Normal;
- 0.4 - 1.0 Investigate (HPV);
- 1.0 - 2.0 Potential accelerated oxidation in progress (HHPV); and

- > 2.0 Serious heating/fire.

Carbon Monoxide/Carbon Dioxide Ratio

This ratio is based on the change of ratio of carbon monoxide produced to carbon dioxide produced as a function of coal temperature which is defined in Equation 2.

$$\frac{(CO_f - CO_i)}{(CO_{2f} - CO_{2i})} \qquad (2)$$

Where:

- f - denotes final
- i - denotes initial

This ratio is independent of dilution with fresh or seam gas except when the seam gas is carbon dioxide. The CO_2 value must be corrected for the carbon dioxide in fresh air.

The values for this ratio are:

- <0.02 Normal;
- <0.05 temperature of coal < 60 °C (HPV);
- <0.10 temperature of coal < 80 °C;
- <0.15 temperature of coal < 100 °C (HHPV); and
- <0.35 temperature of coal < 150 °C.

These are for Tube Bundle alarm set points, used only as indictors to investigate other trends or ratios.

4.5 Commissioning & Operation

4.5.1 Gas Drainage System

Gas drainage and goaf drainage are integral parts of gas management for Grosvenor and they are addressed in **GRO-16-PHMP- Methane Drainage**.

4.5.2 Ventilation System

Gas management by diluting liberated gas into the ventilation system is a major control at Grosvenor and is addressed in a separate PHMP – refer **GRO-15-PHMP-Ventilation**.

4.5.3 Gas Monitoring Permit System

Coal Mine Workers must not interfere with any telemetric gas detectors or tube bundle gas sampling point without authorisation from the Ventilation Officer.

A permit form must be issued by the Ventilation Officer before any gas detector or gas sample point can be:

- Installed;
- Relocated; or
- Removed.

The permit form will state:

- Current location of the gas detector or gas sample point;
- Proposed location of the gas detector or gas sample point;
- Work to be completed (install / relocate / remove);
- Alarm set points
- Date required.

The Ventilation Officer must attach instructions to the permit for any work that is not routine.

Permits are not required to repower, calibrate, service, clean or repair any gas detector or gas sample point.

4.5.4 Underground Telemetric (Real Time) Gas Detectors

All underground gas detectors must be rated for an explosion protection category of Ex ia or EX s. All other equipment forming part of the gas monitoring system must be rated for an explosion protection category Ex ia. They must be connected to an IS uninterruptable electrical power supply (UPS).

4.5.5 Underground Tube Bundle Gas Sample Points

All underground tube bundle gas sample points must be installed as per GRO-5864-SWI-Installation of the Tube Bundle System.

A SCADA system similar in capability to the SIMTARS SafeGas / SeamGas software must be used at Grosvenor Mine to monitor telemetric (real time) gas detectors and tube bundle gas analyser results.

As a minimum the SCADA system must:

- Display outputs from all gas detectors simultaneously in the mine control room scaled to read gas concentrations or values calculated from the gas concentrations (e.g. graham's ratio, CO / CO2 ratio, gas explosibility);

- Allow analysis of gas detector outputs (graphing and calculations);
- Record and automatically back up gas detector outputs for future use;
- Allow alarm levels to be set within the software based on detector outputs (gas concentrations) and values calculated from the detector outputs, e.g. graham's ratio, CO / CO2 ratio, gas explosibility;
- Automatically activate audible and visual alarms when a pre-set alarm level is reached; and
- Allow alarms to be acknowledged and logged for later review.

The SCADA system must be connected to an uninterruptable electrical power supply (UPS).

4.5.6 Gas Alarm Log

A gas alarm log must be maintained and updated by the person in charge of the control room during each shift.

All gas alarms that activate must be acknowledged in accordance with the standard operating procedure for acknowledging gas alarms - refer **GRO-68-SOP-Acknowledging Gas Alarms Underground**.

As a minimum for each alarm event, the gas alarm log must record the:

- Date and time of the event;
- Location of the gas detector that triggered the alarm;
- Alarm that was triggered (e.g. CO concentration, CH4 concentration, Graham's ratio etc.);
- Value recorded;
- Automatic action (if any) triggered by the alarm (e.g. power tripped / plant shut down etc.)
- Person's notified by the control room operator;
- Action taken by person notified;
- Time when the detector returned to a non-alarm state.

The gas alarm log must be reviewed and signed every shift by the on-shift Undermanager and Control Room Operator and also the oncoming Undermanager and Control Room Operator. The log should also be reviewed and signed on a regular basis by the Underground Mine Manager and the Ventilation Officer.

4.5.7 Gas Alarm Levels

If an alarm level or action is not set elsewhere in this PHMP or in **GRO-750-TARP-General Body Contaminant**, then an audible and visual alarm must be activated in the mine control room if any gas detector underground records gas levels that exceed stipulated alarm thresholds

4.5.8 Mine Equipment

All gas monitoring equipment must be checked as part of the site introduction process.

4.5.9 Action if Methane Detected

All workers must adhere to the standard operating procedures for taking action when methane is detected, i.e.:

- **GRO-69-SOP-Action Taken if Methane Detected; and**
- **GRO-70-SOP-Action Taken if Methane Detector Activates or is Non-operational**.

4.5.10 General Back up for Gas Monitoring

All workers must adhere to the standard operating procedure **GRO-71-SOP-General Back Up for Gas Monitoring System** in the event that all or part of the gas monitoring system fails or becomes non-operational.

4.5.11 Calibration of Gas Monitors

All gas monitors are to be calibrated in line with AS2290.3 as a minimum and under the direction of the maintenance strategy established by the Electrical Engineer Manager.

Daily

The Gas Chromatograph will be calibrated once every 24 hours, if required for use.

Shiftly

All portable hand held gas monitors will be zeroed to fresh air and injected with a known quantity of span gas prior to each time the instrument is taken underground (bump test).

Weekly

Weekly calibration of monitors will be carried out for:

- Tube bundle IR analysers;
- All face equipment monitors; and
- All machine mounted monitors.

Monthly

The monthly calibration of gas monitoring shall include:

- Tube bundle sample points;

- Portable hand held monitors;
- All outbye environmental monitors;
- All homotropal monitors.
- NERZ / ERZ1 monitors; and
- Return sensors.

Six (6) Monthly

All gas monitors (except for the GC) on site will be required to undergo a NATA calibration every 6 months.

Annually

The GC is serviced annually or more frequently by SIMTARS (there is no NATA calibration for a GC).

4.6 Surveys

4.6.1 Statutory Inspections

Air flow and gas concentrations must be measured and recorded by the ERZ Controller at each working face at least once during each working shift. ERZ Controllers must monitor for both general body gas concentrations and the presence of layering.

Statutory inspections of mine returns must be conducted routinely. Gas concentrations must be measured and recorded during each inspection.

4.6.2 Monthly Ventilation Surveys

As a minimum, the monthly ventilation survey must record and report the gas concentrations (O_2, CO_2, CH_4, CO) at;

- Roadways at the base of the upcast shaft;
- Return airways from each separate ventilation split;
- Intake airways at the NERZ / ERZ1 boundary for each panel;
- Exhaust from each auxiliary fan.

Calculations shown in the report must include the:

- Gas make for CO and CH_4;
- Gas explosibility;
- CO / CO_2 ratio; and

- Graham's ratio.

4.7 Maintenance

The Mechanical Engineering Manager and Electrical Engineering Manager shall ensure maintenance schedules for all gas monitoring plant are in place and effective. Gas monitoring plant includes:

- Hand held (portable) gas detectors;
- Electrical sensors deployed at the mine for gas detection and monitoring;
- Tube bundle analysers and software;
- SCADA system and software;
- Gas chromatograph;
- Gas drainage plant;
- Goaf drainage plant;
- Auxiliary power units (generators) and UPS system.

5. Control Management

5.1 Risk and Critical 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 Operation Procedures, Standard Work Instructions and other general procedures.

5.2 Grosvenor Safety & Health Management System

The elements of the ***Grosvenor Safety & Health Management System*** required to manage the risks associated with this principal Hazard and the position responsible for that part of the system are listed in Table 3.

Table 3 Grosvenor Mine Safety & Health Management System

Grosvenor Safety & Health Management System Element	Owner
Principal Hazard Management Plans	
GRO-8-PHMP-Explosions	Underground Mine Manager
GRO-5351-PHMP-Underground Fire	Underground Mine Manager
GRO-1440-PHMP-Toxic & Irrespirable Atmospheres	Underground Mine Manager
GRO-1398-PHMP-Outburst	Underground Mine Manager
GRO-10-PHMP-Spontaneous Combustion	Underground Mine Manager
GRO-16-PHMP-Methane Drainage	Underground Mine Manager
GRO-15-PHMP-Ventilation	Underground Mine Manager
GRO-13-PHMP-Emergency Response	Underground Mine Manager
Standard Operating Procedures	
GRO-77-SOP Underground Workplace Inspections	Underground Mine Manager
GRO-70-SOP Action to be Taken if a Methane Detector Activates or is Non-Operational	Underground Mine Manager
GRO-78-SOP Working in a contaminated atmosphere	Underground Mine Manager
GRO-68-SOP Acknowledging gas alarms underground	Underground Mine Manager
GRO-56-SOP Ventilating underground work places	Technical Services Manager
GRO-58-SOP Action taken if the ventilation system fails	Underground Mine Manager
GRO-71-SOP General back up for the Gas Monitoring System	Underground Mine Manager
GRO-69-SOP Action taken if methane is detected	Underground Mine Manager
GRO-62-SOP Changing gas alarm levels	Underground Mine Manager
Hazard Management Plans	
Mine Inspection System	Underground Mine Manager
Other systems and procedures	
Permit to Mine	Underground Mine Manager
Panel Standards	Operations Manager
Borehole Intersection Notice	Technical Services Manager
Real time Gas Monitoring Change authority form	Underground Mine Manager
Gas Well monitoring	Seamgas Manager
Gas monitoring TARPS (Gas and Atmosphere Management)	Underground Mine Manager
Gas bag sampling	Underground Mine Manager

5.1

5.2

5.3

5.4 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 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.

6. 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. Established Trigger Points act as indicators of the change in conditions or hazards and the mandatory actions required to be taken in response to those triggers are presented in a tables for easy reading by personnel in the workplace.

7. Resources

The following organisational, systems and physical resources are required to implement the critical controls for this plan.

7.1 Systems

This plan must be implemented in conjunction with the following Grosvenor sub-ordinate procedures plans and processes

i. Ventilation Principal Hazard Management Plan (**GRO-15-PHMP-Ventilation**);

ii. Toxic/Irrespirable Atmosphere Principal Hazard Management Plan (**GRO-1440-PHMP-Irrespirable Atmosphere);**

iii. Spontaneous Combustion Principal Hazard Management Plan (**GRO-10-PHMP-Spontaneous Combustion**)

7.2 Physical resources

i. Computer simulation software (VentSim Visual Premium or equivalent);

ii. SCADA system (Safegas / Seamgas or equivalent);

iii. Gas detectors;

iv. Hardware;

v. Tube bundle analyser and system;

vi. Hand held gas detectors; and

vii. Gas Chromatograph.

8. Communications

Information pertaining to this plan shall be communicated to all coal mine workers at the Grosvenor mine – refer **GRO-205-PRO-Communication, Consultation and Involvement**.

9. Training and Competencies

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

10. 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.

11. Records

The following records shall be maintained in accordance with the requirements of this Plan:

- Monthly ventilation survey reports
- Gas detector relocation permits
- Workplace inspection and audit records
- Statutory inspections
- Continuous telemetric and tube-bundle gas monitoring results
- Test and calibration results for all gas monitoring and detecting equipment
- Introduction to site equipment inspections
- Equipment commissioning records
- Plant inspection and maintenance records.
- Gas bag analysis

12. 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

13. 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 Document Control Standard, 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.

14. 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.

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.

15. Internal References

Internal documents referenced during the development of this PHMP include-

15.1 Grosvenor Coal Mine SHMS

- GRO-1435-PLAN-Grosvenor Mine Overview Plan
- GRO-201-PRO-Risk Management
- GRO-15-PHMP-Ventilation
- GRO-10-PHMP-Spontaneous Combustion
- GRO-71-SOP-General backup for gas Monitoring System
- GRO-70-SOP-Action Taken if Methane Detector Activates or is Non-Operational
- GRO-68-SOP-Acknowledging Gas Alarms Underground
- GRO-750-TARP-General Body Contaminant
- GRO-69-SOP-Action Taken if Methane Detected
- GRO-62-SOP-Changing Gas Alarm Levels Underground

- GRO-205-PRO-Communication, Consultation and Involvement
- GRO-204-PRO-Training Scheme
- GRO-5444-RA-Gas Management
- GRO-5080-RA-Grosvenor Baseline Risk Assessment

15.2 Forms

- Gas Detector Relocation Permit

16. External References

External documents referenced during the development of this procedure were:

16.1 Legislation

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

16.2 Other references

- Grosvenor Life of Mine Ventilation Plan R10-005. Moreby, Roy. August 2010
- MDG 1006 Technical Reference Spontaneous Combustion
- Chief Inspectors Hazard Database - http://mines.industry.qld.gov.au/safety-and-health/publications-guides.htm
- GTS 02 Integrated Risk Management Standard
- AA_RD_24 Operational Risk Management Process

17. Document Review

Issue No.	Issue Date	Description	Approver
6	19/07/2016	Inclusions of Internal Document Audit in appendix	Justin Joubert SHE Manager
7	27/06/17	Administrative corrections	Cec Iver Underground Mine Manager
8	26/07/2018	Revision of content, update to tables and document references post PHMP Bow-Tie Review (GRO-5444-RA-Gas Management) 2017.	Cec Ivers Underground Mine Manager

18. Appendix A: Internal Document Audit

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

MEASUREMENT AND EVALUATION				
Measurement				**Findings and Comments**
1. The short term mine plan contains an up to date layout and location of all gas monitoring points (telemetric and tube bundle) and a schedule showing the approximate timing for any changes or relocations of monitoring locations. - Review the current short term plan and validate that these are displayed.				
Compliant ☐	Non Compliant ☐	Requires Improvement ☐	N/A ☐	
2. The mine ventilation system (software) is updated monthly and following any ventilation change. - Validate that is system has been updated and being used for gas management planning.				
Compliant ☐	Non Compliant ☐	Requires Improvement ☐	N/A ☐	
3. Pre and post-drainage design targets for the mine have been achieved. - Obtain records of development and longwall gas concentrations and cross-reference against design targets in those areas. E.g. LW tailgate, development panels, NERZ / ERZ1 boundaries, goaf etc.				
Compliant ☐	Non Compliant ☐	Requires Improvement ☐	N/A ☐	
4. The Control Room Operator (CRO) has been trained in the use, maintenance and understands the operational parameters of the gas chromatograph located in the control room. Validate this by challenging the knowledge of the CRO on shift: - Have they been trained in its use? - Is the training current? Do they need refreshing? - Are they confident they know what to do and how to respond?				
Compliant ☐	Non Compliant ☐	Requires Improvement ☐	N/A ☐	
5. Calibrations of different gas monitoring systems can occur daily, shiftly, weekly, monthly, 6 monthly and annually. - Sample a range of gas monitoring systems and validate that they are up to date with their calibrations and records are maintained.				
Compliant ☐	Non Compliant ☐	Requires Improvement ☐	N/A ☐	

6. The MEM and EEM have ensured that maintenance schedules for all gas monitoring plant are in place and these maintenance activities have been included into the mine work order system. Gas monitoring plant includes: - Handheld / portable detectors; - Electrical sensors; - Tube bundle system; - SCADA system; - Gas chromatograph; - Gas drainage plant; and - Auxiliary power units and UPS systems.				
Compliant ☐	Non Compliant ☐	Requires Improvement ☐	N/A ☐	

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

AUDIT COMPLETED BY			
Name		Signature	