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**PRINCIPAL HAZARD MANAGEMENT PLAN**

**(PHMP)**

**EXPLOSIONS**

AGM.002.001.0386

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# 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, it’s 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 it’s 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.

# Scope

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

# Historical Context

## 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  |

## 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

# 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 *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 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  |

# Principal Hazards and Risk Management

## 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.

## 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.

## 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**).

## 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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PHMP

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Explosions





### **Figure 1 Explosions Causation and Release Fault Tree (abbreviated)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
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Explosions


### **Figure 2 Explosions Consequences and Impacts Event Tree (abbreviated)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
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# Control Management

## 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.

## 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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## 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 **GRO9637-REG-Critical Control Register**. **…**

# 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**

# 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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# 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.**

# 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.

# 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.

# 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  |

# 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.

# 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

# 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.

# Internal References

Internal documents referenced during the development of this plan were:

## 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

## 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  |

# External References

External documents referenced during the development of this procedure were:

## Legislation

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

## 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/publicationsguides.htm](http://mines.industry.qld.gov.au/safety-and-health/publications-guides.htm)

# 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

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Explosions



# Appedix A: Internal Document Audit

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

|  |  |
| --- | --- |
| **MEASUREMENT AND EVALUATIO** | **N**  |
| **Measurement**  | **Findings and Comments**  |
| 1. Stone Dusting to reduce non-combustible matter. * 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 **□** Non Compliant **□** Requires Improvement **□** N/A **□**  |
| 2. Effective water sprays on underground equipment (frictional heating and coal dust accumulation). * 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 **□**  | Non Compliant **□**  | Requires Improvement **□**  | N/A **□**  |
| 3. Elimination of explosive levels of gas. - 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 **□**  | Non Compliant **□**  | Requires Improvement **□**  | N/A **□**  |
| 4. A HMP has been developed and implemented for Frictional Ignition.  |   |
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PHMP

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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 **□**  | Non Compliant **□**  | Requires Improvement **□**  | N/A **□**  |

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

**AUDIT COMPLETED BY**

|  |  |  |
| --- | --- | --- |
|   | Signature  |   |

Name

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
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