



VULCAN MINE

Standard Operating procedure

Flammable and Toxic Gas in the Work Environment



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1. PURPOSE

The purpose of this procedure is to describe requirements and to effectively manage hazards and risks associated with flammable or toxic gas at the Vulcan Mine.

2. SCOPE

This procedure is applicable to all persons at the Vulcan Mine including employees, contractors and visitors.

The controls within this procedure are mandatory.

3. DEFINITIONS

Authorised Person	A person who has the required competencies and who has been appointed by the Site Senior Executive to carry out a designated scope of duties.
CMSHA	Queensland Coal Mining Safety and Health Act (1999).
CMSHR	Queensland Coal Mining Safety and Health Regulation (2017).
CMW	Coal Mine Worker.
Competent Person	A person who has, through a combination of training, education and experience, acquired knowledge and skills enabling that person to perform correctly a specified task.
DNRME	Department of Natural Resources, Mines and Energy.
HSET	Health, Safety, Environment and Training
IEC	International Electrotechnical Commission.
JHA	Job Hazard Analysis.
MOP	Mine Operating Procedure.
OCE	Open Cut Examiner.
OEM	Original Equipment Manufacturer.
PPE	Personal Protective Equipment.
PPM	Parts Per Million.
SHMS	Safety and Health Management System.
Spon-com	Spontaneous Combustion.
Take 5	Personal Risk Assessment.

4. PROCEDURE

4.1. Awareness of Hazards

The Vulcan Mine risk management processes shall be applied.

All CMWs shall monitor their health for symptoms of illness due to exposure potentially harmful gasses. Symptoms may include but are not limited to:

- nausea;
- vomiting;
- headache;
- dizziness;
- drowsiness;
- feeling cold;
- irritation of respiratory tract;
- irritation of eyes; and
- burning or tingling sensation on tongue.

Notable or flammable toxic gases include:



- Sulphur Dioxide (SO₂) (copper coin/brass taste at the back of the mouth);
- Oxides of Nitrogen (NO_x) (sometimes a yellow or brown colour);
- Hydrogen Sulphide (H₂S) (rotten egg/cabbage smell);
- Methane (CH₄) (colourless, odourless, and tasteless); and
- Carbon Monoxide (CO) (colourless, odourless, and tasteless).

CMWs shall be aware of a possible build-up of hydrogen sulphide (H₂S) gas in areas where water has been stagnant for long periods of time and from seam gas. If any person has concerns or doubts about entering a potential gas risk zone, ensuring their own and others safety shall be the first consideration. Refer also to the VUL-SOP-096a-Confined Spaces.

4.2. Identification of Gas

Potential or known high risk areas shall be identified, assessed and recorded within the VUL-REG-18-03-Risk Register. These locations shall be sign-posted and communicated to the workforce.

“No Naked Flame” signs shall be erected at locations where there may be flammable gas present.

Prior to entering a work area where hazardous gas is potentially present, monitoring of the atmosphere shall be conducted by appropriately trained personnel. The table below represents gases that may potentially be found at the Vulcan Mine and possible locations.

Table 1: Identification of Locations for Gas Monitoring

Gas	Possible Locations and Triggers
Methane (CH ₄)	Pit floor, confined spaces, sewage plant
Carbon Monoxide (CO)	Near combustion processes, spon-com coal, engines, product stockpiles
Carbon Dioxide (CO ₂)	Depressions, sumps, tunnels, bottom of the pit (survey, pump etc.)
Hydrogen Sulphide (H ₂ S)	Stockpiles, some pit areas, tunnels
Sulphur Dioxide (SO ₂)	Combustion of coal, spon-com coal
Nitrogen Dioxide (NO ₂)	Blast Fumes
Nitric Oxide (NO)	Blast Fumes
Other hydrocarbon gases e.g. LPG	Confined spaces, workshops

4.3. Risk Assessment

A JHA shall be conducted in the following circumstances:

- prior to work in any confined space (primary reference here is VUL-SOP-096a-Confined Spaces);
- prior to work in any work area previously identified as hazardous due to the presence of gas; and
- prior to entry into any other work area where current conditions or the work task involved can potentially expose personnel to hazardous gases.

In all cases where JHAs are required to consider the potential presence of hazardous or toxic gas, monitoring requirements prior to entry, during the task, at completion, and on-going shall be clearly defined.

Also refer to the requirements of the VUL-SOP-096a-Confined Spaces.

4.4. Monitoring

4.4.1. Olfactory (Smell)

Poor or dangerous atmospheres can often be detected by an unusual or unpleasant smell. CMWs who detect odours that in their opinion may be a sign of dangerous atmospheric conditions shall report the event to their supervisor. The supervisor shall organise for appropriate gas testing.

4.4.2. Equipment

Gas monitors shall be compliant with IEC standards and shall be used in accordance with the OEM specifications.



Any persons required to utilise this equipment shall be appropriately trained and competent.

Where the presence of gases is in connection with a confined space also refer to monitoring requirements contained in the VUL-SOP-096a-Confined Spaces

4.4.3. Methane (CH₄)

- Methane is a gas found in coal-seams (and other places) that has a flammable range from approximately 5% to 15%.
- Methane requires monitoring to detect its presence as it is odourless, colourless and tasteless.
- It is low density and disperses readily once it desorbs from the coal seam into the atmosphere.
- Methane is generally not a problem at open-cut mines as the gas disperses very rapidly on release to the atmosphere. However, there are two circumstances where methane could accumulate in sufficient quantities and concentrations to pose a hazard:
 1. In blast holes in faulted ground. Irrespective of the depth of the open cut, methane shall be expected in any blast hole that intersects the coal seam where faulting has been encountered in the operations. Methane concentrations at the top of the blast hole could be well over 5% and within the flammable range.
 2. From fissures in the ground at or close to the base of blasted ground, i.e. within one bench level of the base of a shot. This is more common in areas where faulting has been encountered in the operations. Methane could accumulate in the coal seam against the fault and be released during mining operations.
- Where methane readings are greater than the trigger levels (refer to section 4.4.8), the area supervisor shall be notified immediately and the trigger response actions implemented.

4.4.4. Carbon Monoxide (CO)

- Carbon monoxide is a product of incomplete combustion of hydrocarbons - coal, diesel and wood being the most probable sources at a mine site.
- It is odourless, colourless and tasteless, making it impossible to detect without a monitor.
- It is highly toxic at low concentrations and displaces oxygen in the blood stream.
- Monitoring shall be initiated whenever:
 - spontaneous combustion of coal occurs and personnel are working in the immediate area. CO is deemed a hazard whenever spontaneous combustion of a stockpile occurs and the products of combustion can be detected, e.g. white smoke, heat, flame; or
 - combustion engines are used in or near a confined space (refer VUL-SOP-096a-Confined Spaces)
- Where CO readings are greater than the trigger levels (refer to section 4.4.8), the area supervisor shall be notified immediately and the trigger response actions implemented.

4.4.5. Carbon Dioxide (CO₂)

- Carbon dioxide is a gas found naturally in the atmosphere (approx. 400 ppm) but can be found in high enough concentrations in coal seams to be considered hazardous.
- It is denser than air and has the potential to accumulate in depressions and sumps in the pit floor.
- It is odourless and colourless but can be detected in the saliva as well as in other physiological ways.
- When inhaled at elevated concentrations it causes the breathing rate to increase, leading to fainting and eventually asphyxiation at higher concentrations.
- Where CO₂ readings are greater than the trigger levels (refer to section 4.4.8), the area supervisor shall be notified immediately and the trigger response actions implemented.

4.4.6. Hydrogen Sulphide (H₂S)

- Hydrogen sulphide is a gas that is found in coal seams and is very toxic in small concentrations.
- It is colourless, water soluble, has a very strong smell and is commonly referred to as “rotten egg gas”.



***Individuals can become desensitised to the smell following extended exposure to H₂S.
Gas monitoring shall be used to confirm presence.***

- Hydrogen sulphide does not readily desorb from coal but is released every time the coal is broken down, e.g. screens, bins, excavation and other handling facilities.



- Monitoring shall be conducted whenever the signs of H₂S and the associated symptoms are identified.
- Where H₂S readings are greater than the trigger levels (refer to section 4.4.8), the area supervisor shall be notified immediately and the trigger response actions implemented.



The presence of H₂S is a potential indicator of reactive ground and the blast crew and technical services department must be notified.

4.4.7. Sulphur Dioxide (SO₂)

- Sulphur dioxide is a common pollutant we are exposed to every day at very low levels.
- Higher exposure levels can be found at coal mines where the combustion of coal occurs.
- SO₂ is odourless under 0.5 ppm and is colourless.
- SO₂ is a mild respiratory irritant above 2 ppm, bronchoconstriction can occur above 5 ppm, with life threatening health effects above 15 ppm.
- Where SO₂ readings are greater than the trigger levels (refer to section 4.5.8.), the area supervisor shall be notified immediately and the trigger response actions implemented.

4.4.8. Trigger Levels

Table 2 : Flammable and Toxic Gas Trigger Levels

Gas	Action Trigger			
	Time-Weighted Average (TWA)	Short Term Exposure Limit (STEL)	Peak Limit	Notification
Methane (CH₄)	n/a	n/a	0.25% volume	Supervisor and OCE
Carbon Monoxide (CO)	30 ppm 0.003% volume 31 mg/m ³	200 ppm (15-min) 100 ppm (30-min) 60 ppm (60-min)	n/a	Supervisor and OCE
Carbon Dioxide (CO₂)	12,500 ppm 1.25 % volume 22500 mg/m ³	30,000 ppm 3% volume 54,000 mg/m ³	n/a	Supervisor and OCE
Sulphur Dioxide (SO₂)	2 ppm 0.0002% volume 5.2 mg/m ³	5 ppm 0.0005% volume 13 mg/m ³	n/a	Supervisor and OCE
Hydrogen Sulphide (H₂S)	10 ppm 0.001% volume 14 mg/m ³	15 ppm 0.0015% volume 21 mg/m ³	n/a	Supervisor and OCE
Nitrogen Dioxide (NO₂)	3 ppm 0.0003% volume 5.6 mg/m ³	5 ppm 0.0005% volume 9.4 mg/m ³	n/a	Supervisor and OCE
Nitric Oxide (NO)	25 ppm 0.0025% volume 31 mg/m ³	n/a	n/a	Supervisor and OCE
Other hydrocarbon / flammable gases e.g. LPG	Refer to the VUL-SOP-096a-Confined Spaces and VUL-SOP-096c(ii)-Hazardous Hot Work. The concentration of any flammable gas, vapour, mist or dust in the atmosphere of the space shall be less than 5% of its LEL			

Notes:

To convert ppm to % divide by 10,000

Time-weighted average (TWA)' means the average airborne concentration of a particular substance when calculated over a normal eight-hour working day, for a five-day working week.

Short term exposure limit (STEL)' means a 15-minute TWA exposure which should not be exceeded at any time during a working day even if the eight-hour TWA average is within the TWA exposure standard. Exposures at the STEL should not be longer than 15 minutes and should not be repeated more than four times per day. There should be at least 60 minutes between successive exposures at the STEL.

Peak limit means a maximum or peak airborne concentration of a substance determined over the shortest analytically practicable period of time which does not exceed 15 minutes.



4.4.9. Trigger Response Actions

- Evacuate the immediate area and barricade in accordance with the VUL-SOP-094-Check, Examine and Restrict Work Areas.
- In the case of any flammable gas, extinguish any ignition sources in the area if safe to do so.
- Report the readings to the area supervisor, superintendent and OCE as soon as practicable.
- The area supervisor shall record the time, location and readings in shift log.
- Conduct on-going gas monitoring using appropriately trained personnel with necessary PPE.
- Prevent personnel from re-entering the area until it has been checked and deemed safe for re-entry.
- Communicate the hazard to the oncoming shift, through the prestart meetings.

4.5. Hot Work

The area supervisor, in conjunction with the OCE, shall monitor for flammable gases prior to any cutting or welding work being conducted in a location within the pit, where high methane levels could be expected.

A VUL-FRM-19-05-Hot Work Permit shall be completed for all hot work in accordance with the VUL-SOP-096c(ii)-Hazardous Hot Work.

When performing hot work, careful consideration needs to be given to gases which may build up in confined or sealed compartments as these may create a fire or explosion hazard.

When performing hot work in pit, gas monitoring must be conducted before work is to commence, and as needed as job progresses due to gases which may build up as these may create a fire or explosion hazard.

4.5.1. Coal Stockpiles

When reclaiming coal from a stockpile showing signs of spontaneous combustion the following controls shall be followed:

- parking on the upwind side of the stockpile;
- no pedestrian access;
- moving equipment away from stockpile if any physiological effects are experienced and reporting to supervisor;
- request area supervision to arrange the area to be monitored with results reported to supervision and personnel operating in the area; and
- only re-entering the area when gas contents are within acceptable limits.

5. ROLES AND RESPONSIBILITIES

SSE	Shall review and approve this procedure.
HSET Superintendent	Shall ensure that all provisions of this procedure are implemented, and that compliance is achieved.
Managers/Superintendents	Shall be responsible for their area of operations and the implementation and application of this procedure; Provide adequate training, information, structure and supervision to ensure that this procedure is implemented; Carry-out a periodic review of activities to ensure the appropriate application and understanding of this procedure; and Ensure immediate and appropriate steps are taken to investigate and rectify any risks to health and safety arising from these activities.
Supervisors	Ensure all CMWs are familiar with, have access to and comply with the requirements set out in this procedure.
All CMWs (including visitors and contactor)	Shall comply with the requirements of this procedure.



6. REFERENCES

- AS/NZS 1716:2012 Respiratory protective devices
- AS/NZS 60079.10.1:2009 Explosive atmospheres – Classification of areas – Explosive gas atmospheres
- AS/NZS 60079.29.2:2016 Explosive atmospheres - Gas detectors - Selection, installation, use and maintenance of detectors for flammable gases and oxygen
- Coal Mining Safety and Health Act 1999 (Qld)
- Coal Mining Safety and Health Regulation 2017 (Qld)
- DNRME Significant Incident 22 Noxious gas hazard in an open cut coal mine
- DNRME Safety Bulletin 47 Tyre fires, pyrolysis and explosions
- DNRME Safety Alert 61 Flammable toxic gases in open cut coal mines
- DNRME Safety Alert 108 Gas barbecue safety
- DNRME Safety Bulletin 120 Exposure to toxic gases associated with spontaneous
- DNRME Safety Alert 158 Ignition of Gas in surface drill holes
- Guidance Note on the Interpretation of Exposure Standards for Atmospheric Contaminants in the Occupational Environment NOHSC 3008 (1995) 3rd Edition
- VUL-FRM-19-05-Hot Work Permit
- VUL-REG-18-03-Risk Register
- VUL-SOP-094-Check, Examine and Restrict Work Areas
- VUL-SOP-096a-Confined Spaces
- VUL-SOP-096c(ii)-Hazardous Hot Work

7. REVIEW

This document shall be reviewed at a minimum every two years, or as follows:

- when there is a change of method and/or technology and/or legal or other requirement that may affect the accuracy of this document;
- when operational changes occur that effect the currency of the document;
- when there has been a significant event to which this document was relevant; and
- as a result of relevant audit findings.

8. DOCUMENT CONTROL

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