



VULCAN MINE

Management Plan Blast Fume



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PURPOSE

The purpose of this Fume Management Plan (FMP) is to provide an efficient management system which defines and integrates the responsibilities and functions within Vulcan Mine in order to achieve safe outcomes.

1. SCOPE AND APPLICABILITY

This FMP is applicable to Vulcan Mine CMW, contractors, neighbours, the community and visitors. It covers the management requirements for post blast Fume exposure.

2. DEFINITIONS

AN	Ammonium Nitrate
ANE	Ammonium Nitrate Emulsion. Also referred to as Emulsion Phase (EP).
BEZ	Blast Exclusion Zone
CMW	Coal Mine Workers
CTO	Critical Task Observation
FMZ	Fume Management Zone
HST	Health, Safety and Training
MPU	Mobile Processing Unit
NOX	Nitrogen Dioxide Gases
OCE	Open Cut Examiner
QAQC	Quality Assurance and Quality Control
SOP	Site Operating Procedure
SSE	Site Senior Executive
VOD	Velocity of Detonation (m/s)

3. BACKGROUND

Blasting operations in mining predominantly use ammonium nitrate-based explosives in the form of ammonium nitrate fuel oil (ANFO) or ammonium nitrate emulsion (ANE). In theory, an ideal ammonium nitrate explosive reaction generates products:

- H₂O (in the form of steam)
- CO₂ (carbon dioxide)
- N₂ (nitrogen).

The application of blasting explosives in the field, under variable conditions, results in non-ideal explosive reactions that can produce three main toxic gases (in order of decreasing toxicity):

- NO₂ (nitrogen dioxide)
- NO (nitric oxide)
- CO (carbon monoxide).

The most harmful is nitrogen dioxide, which is identifiable by the generation of orange/brown Fume. There are many factors that can contribute to the generation of fume which is an outcome of the ammonium nitrate explosives not detonating ideally.

4. POTENTIAL CAUSES AND IMPACTS OF NO_x

The following list are known contributing factors to the generation of NO_x.

- Incorrect explosive formulation,
- Incorrect delivery of product,
- Poor diesel absorption,
- Water ingress in the product during sleep periods,



- Dynamic water,
- Increased product density due to hole depth,
- Insufficient primer energy,
- Inter or intra hole desensitisation,
- Critical diameter (e.g. product slumping into voids or cracks),
- Insufficient relief (e.g. insufficient delay between holes),
- Powder factor too high for the competency of the ground,
- Incorrect pattern design,
- Incorrect product selection,
- Changing weather conditions (e.g. start loading in dry conditions and then severe rain event occurs), and
- Confinement

Blasting generates a large quantity of gases and if the detonation is not ideal NO_x can be produced in various quantities. Exposure to NO_x can cause significant health issues and exposure to CMW and the greater community must be avoided.

5. RESPONSIBILITIES

Drill and Blast Engineer

- Must ensure the following factors are considered when designing the blast.
- pattern parameters,
- hole diameter,
- powder factor,
- product selection,
- short- and long-range weather forecasts,
- integrity of the ground, and
- fume generation history.
- Confinement, i.e. appropriate Stemming Heights and Stemming Material

Drill and Blast Coordinator

- Review the blast design,
- Review the Charge sheets,
- Review the Tie up plans drafted by the Drill and Blast Engineer.
- Discuss all recommended changes to the Drill and Blast Engineer, and
- Review the FMZ and BEZ.

OCE

- Must attend the blast guard meeting,
- Understand/familiar the designated area for sweeping post blast, maintain on going communication with the blast controller, and
- Refer to VUL-TAR-001-Post Blast Fumes

Blast Controller

- Must be competent, authorised and signoff by SSE
- Conducts the blast guard meeting and completes the checklist VUL-FRM-16-02- Blast Controller Checklist.
- Maintain positive communication with the affected Neighbours and local traffic.
- Understand/familiar the designated area for sweeping post blast. Maintain on going communication with any personnel associated with the blast.
- Be aware of the potential for the generation of Blast fume,
- Be aware of the wind speed and direction,
- Be aware of the fall-back positions of each blast guards,
- Limit the number of personnel at the firing point, and
- Refer to VUL-TAR-001-Post Blast Fumes.



Shotfirer

- Ensure the shot is loaded as per the design,
- Communicate any deviation from the design to the Drill and Blast Coordinator and engineer.
- Manage the bench conditions to eliminate or minimise the ingress of water into the holes,
- Actively monitor the weather conditions,
- Review the daily MPU load summary sheets,
- Ensure product density checks are performed
- Completes the [VUL-FRM-16-15-Fume Checklist](#), and
- Refer to VUL-TAR-001-Post Blast Fumes.

MPU Operators

- Ensure the shot is loaded as per the design,
- Communicate any deviation from the design to the shotfirer,
- Monitor the hole conditions to ensure any changes to product selection can be managed,
- Ensure product density checks are conducted,
- Ensure the MPU is calibrated and
- Report any product (ANE/AN) quality changes to Drill and Blast Coordinator prior loading the MPU.

Blast Guards

- Must be competent, authorised and signoff by SSE
- Must attend the blast guard meeting
- Be aware of the potential for the generation of blast fumes,
- Be aware of the wind speed and direction, and
- Be aware of their fall-back position if directed by the Blast Controller, and
- Refer to VUL-TAR-001-Post Blast Fumes

Blast Sweeper

- Must be competent, authorised and signoff by SSE
- Must attend the blast guard meeting
- Be aware of the potential for the generation of Blast fume,
- Be aware of the wind speed and direction,
- Understand/familiar the designated area for sweeping post blast, and
- Refer to VUL-TAR-001-Post Blast Fumes.

6. RISK MANAGEMENT

This plan is supported by a risk assessment that considers the risks for the generation of NO_x during the initiation of a blast. The main areas considered during the risk assessment were:

- Explosive formulation and quality,
- Geology,
- Blast design,
- Product selection,
- Loading practices, and Pre-blast planning controls.

7. Management of Designing a shot

☐ A competent person will be assigned responsibility for the design of each shot and consider the following:

- Drill and Blast design is to be conducted as per VUL-MOP-097-Drill and Blast Design,
- The hardness and nature of the strata,
- The blast geometry including the number of available free faces and the proximity of surface structures and neighbours,
- A blast pack is finalised for each shot and handed over to the Shotfirer



- All deviations from the approved blast design must first be approved by the Drill and Blast Engineer.

8. Management of Loading Blastholes

The Shotfirer is in charge of the shot and all personnel on the shot. Before commencing any loading, the Shotfirer shall carry out the following:

- Loading of blast holes as per VUL-SOP-116g-Charging & Firing Explosives.

9. Management of Pre-Initiation Weather Checks

Shots shall not be fired until a pre-initiation weather check has been completed and the relevant weather data recorded on the blast clearance plan. Data includes at a minimum, wind speed and wind direction.

The Blast Controller shall ensure the assigned blast guards hold the necessary site competencies, know their position and area of responsibility during the blast and the approximate time of the blast. A minimum BEZ of 600metres for personnel is to apply when determining guard locations,

- The blast guards are briefed on the potential for the generation of fume and their secondary fall-back positions.

10. MANAGEMENT OF FUME EXPOSURE

Initial first aid (and precautionary measures that must be undertaken); as per VUL-TAR-001-Post Blast Fumes

The treating medical staff must be aware of what the person has been exposed to.

The treating medical staff should provide the patient with feedback on the signs and symptoms observed when the patient was presented.

Incident Investigation

It is important that all fume events are thoroughly investigated to determine as accurately as possible the causes of the fume. The investigation relies heavily on the availability of accurate records from a blast. If the investigation cannot identify causes for the fume it is most likely the result of inadequate record keeping. When the investigation team finds this situation, it must ensure that all future blasts are conducted with the appropriate records in place.

Monitoring

Monitoring NOx levels after a fume event is important to:

- Increase the information available to investigators determining the amount of fume generated.
- Provide indication to treating medical staff of the possible level of exposure.
- Record exposure to persons and sites that may become the basis of legal claims – this should be identified in a review.
- enables background levels to be established for particular locations.
- identify exposure levels at particular sites.
- assist in estimating the level of fume generated at the blast site.
-

Reportable Fume Event

If the fume event is reportable to the SSE and Inspectorate, then the relevant information has to be provided as per VUL-SOP-116g-Charging & Firing Explosives.

11. Monitoring Equipment

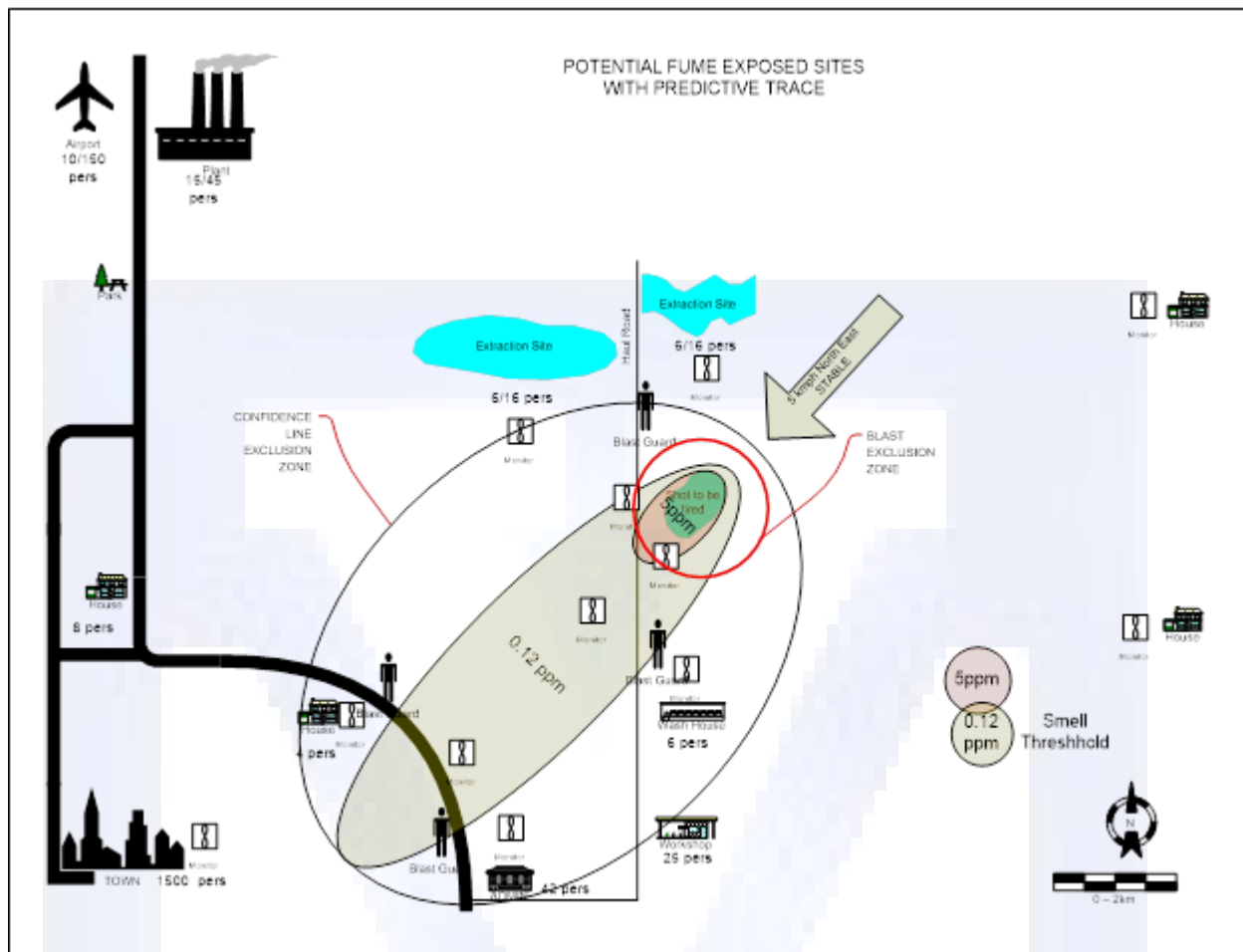
Monitoring equipment (personal or fixed) varies depending on its purpose which could include personal monitoring, site or area monitoring, potentially exposed site monitoring. Specific monitors can be hired or purchased outright. All monitors must remain in calibration and be challenged regularly with the gases they are designed to detect. Monitors may provide a basic warning of a gas and/or log data.



All monitor positions must be accurately recorded with GPS co-ordinates to enable later analysis.

Specify target gases when purchasing to ensure the monitors are able to monitor the target gases.

Monitors are capable of multiple gas detection and should be capable of detecting NO₂, NO and CO.





APPENDIX 1 – CAUSES OF NOX FUME AND MITIGATIONS (ADAPTED FROM AEISG DATA)

Primary Cause 1: Explosive blends and precursors chemical design (pre site delivery)			
Potential Cause	Likely indicators	Control measures	Responsibilities
Chemical formulation of the mixed explosives and/or precursors unknowingly inherently designed to generate fume	NOx fume	Reformulate explosive to meet User Needs Specification	Explosive supplier Explosives Manufacturer
		Change product to one that meets User needs Specification QA/QC product conduct VOD testing when excessive consistent fume events	Mine Operations Manager SSE
Formulation of explosives mixture and/or precursors marginal with regards to sensitivity	Intermittent NOx fume Inconsistent blast performance	Reformulate explosive to meet User Needs Specification	Explosive supplier
		Change product to one with more sensitivity	Mine Operations Manager Explosive supplier
Formulation of explosives mixture and/or precursor marginal with regards to chemical stability	Intermittent NOx fume Inconsistent blast performance	Reformulate explosive to meet User Needs Specification	Explosive supplier
		Change product which has chemical stability	Mine Operations Manager Explosive supplier
Formulation of explosives mixture and/or precursor insufficiently resistant to conditions it is used in	Intermittent NOx fume Inconsistent blast performance	Reformulate explosive to meet User Needs Specification	Explosive supplier
		Change product to one that meets User needs Specification	Mine Operations Manager Explosive supplier
Formulation of explosives mixture and/or precursors not suitable for the prevailing climatic or seasonal conditions	Intermittent NOx fume	Reformulate explosive with suitable precursors	Explosive supplier
		Change raw materials	
		Change product to one that meets User needs Specification	SSE Mine Operations Manager Drill and Blast Engineer



Primary Cause 2: Explosives and precursors' conformance to specification post formulation and pre use			
Potential Cause	Likely indicators	Control measures	Responsibilities
Precursor delivered to mine site out of specification	Intermittent NOx fume Traceable to a precursor which has degraded between manufacture & use Poor blast performance	Investigate with supplier of explosive precursors	Explosive Supplier Mine operations Manager
Precursor degradation during transport and storage	- Frequent NOx fume - All blasts and locations utilising explosive product(s) that incorporate a specific raw material - Poor blast performance	Appropriate storage location, conditions and stock rotation management (i.e. First in / first out)	Mine Operations Manager Explosive Supplier Magazine Keeper
		Appropriate transport and transfer of precursors	Drill and Blast Coordinator Drill and Blast Engineer Explosive Supplier MPU Operator
		Inspection and/or testing of precursors prior to use in accordance with manufacturer's recommendations	Drill and Blast Coordinator Explosive Supplier Shotfirer
Raw material changes	- Frequent NOx fume - All areas associated with loading from a specific delivery system - Product appearance abnormal	Change management procedures in place by suppliers	Drill and Blast Coordinator Explosive Supplier Shotfirer
		Prior notification to suppliers from site change management systems where precursors are supplied by sites, for example customer-supplied fuels	Drill and Blast Coordinator Explosive Supplier Shotfirer
Product past use by date	- Difficulty achieving final density - Separation - Crystallising - Fines - Colour variation - Poor blast performance	Testing to ensure the product is within the manufacturer's specification pH, Density, Viscosity	Drill and Blast Coordinator Mine Operations Manager Explosive Supplier Magazine Keeper
Failure to conduct quality tests	Incomplete documentation	Conduct CTO to ensure compliance with procedures All blast crew to be trained in the potential consequences of failing to ensure the quality of the product loaded	Drill and Blast Coordinator Shotfirer Explosive Supplier



Primary Cause 3: Blast design leading to fume events			
Potential Cause	Likely indicators	Control measures	Responsibilities
Explosives – rock mass properties mismatch	- Intermittent NO_x fume - Unexpected blast results - Flyrock	Follow manufacturer's recommendations on explosive product application	Drill and Blast Coordinator Shotfirer Explosive Supplier
		Review of the site approved technical design.	Site Senior Executive Mine Operations Manager Drill and Blast Coordinator Drill and Blast Engineer
Explosives product selected not suitable for the prevailing ground conditions (water, rock mass strength, etc.)	- Frequent NO_x fume - Poor blast performance	Follow manufacturer's recommendations on explosive product application	Drill and Blast Coordinator Drill and Blast Engineer Shotfirer Explosive Supplier
		Review of the site approved technical design.	Site Senior Executive Mine Operations Manager Drill and Blast Coordinator Drill and Blast Engineer
Insufficient consideration given to blast dynamics	- Intermittent NO_x fume - Unexpected blast results - Misfire product	Follow manufacturer's recommendations on explosive product application	Mine Operations Manager Drill and Blast Coordinator Shotfirer Explosive Supplier
		Review of the site approved technical design.	Site Senior Executive Mine Operations Manager Drill and Blast Coordinator Drill and Blast Engineer
Failure to identify potential causes of fume generation	- Inexperienced designers - Inadequate analysis or records for past blasts	Use of the Pre-Design Checklist as per VUL-FRM-16-05 Drill & Blast Design Assessment	Shotfirer Drill and Blast Engineer Drill and Blast Coordinator



Primary Cause 4: Explosives detonation performance impacted by blast dynamics			
Potential Cause	Likely indicators	Control measures	Responsibilities
Inter-hole explosive desensitisation	- Frequent NOx fume - Blast holes drilled too close together - Blast hole deviation - Inconsistent blast performance	Change design	Drill and Blast Coordinator Drill and Blast Engineer
		Product selection	Drill and Blast Coordinator Drill and Blast Engineer
		Increased control on drilling with deeper hole depth designs and hole orientation	Drill and Blast Coordinator Drill and Blast Engineer Driller
Intra-hole explosive desensitisation in decked blast holes	- Frequent NOx fume - When using decks only - Inconsistent blast performance	Appropriate separation of explosive decks. Initiator timing.	Drill and Blast Coordinator Drill and Blast Engineer
Explosive desensitisation due to the blast hole depth	- Frequent NOx fume - Poor blast performance	Reduce bench height	Site Senior Executive Mine Operations Manager Drill and Blast Coordinator Drill and Blast Engineer
		Ensure adequate relief in deep holes	Drill and Blast Coordinator Drill and Blast Engineer and Mine Planning Engineer
		Follow manufacturer's recommendations on explosive product selection and blast design for deep holes, for example decking where appropriate.	Drill and Blast Coordinator Drill and Blast Engineer and Mine Planning Engineer Explosive Supplier
Inappropriate priming and/or placement	- Intermittent NOx fume - Residue product - Inconsistent blast performance	Follow manufacturer's recommendations on explosive product initiation.	Drill and Blast Coordinator Shotfirer Explosive Supplier
		Review of the site approved technical design.	Site Senior Executive Mine Operations Manager Drill and Blast Coordinator Drill and Blast Engineer
Initiation of significant explosive quantities in a single blast event	Intensity of post-blast fume proportional to explosives quantity used	Reduce blast size in order to reduce total explosive quantity being initiated in the one blast event	Site Senior Executive Mine Planning Engineer Mine Operations Manager Drill and Blast Coordinator Drill and Blast Engineer
		Reduce powder factor	Drill and Blast Coordinator Drill and Blast Engineer.



Primary Cause 4: Explosives detonation performance impacted by blast dynamics			
Potential Cause	Likely indicators	Control measures	Responsibilities
Desensitisation of explosive column from in-hole detonating cord initiation	- Frequent NOx fume - Only in areas where in-hole cord initiation is used - Inconsistent blast performance	Follow manufacturer's recommendations on compatibility of initiating systems with explosives	Drill and Blast Coordinator Drill and Blast Engineer
Primer of insufficient strength to initiate explosive column	- Frequent NOx fume - All blasts using a particular primer type / size - Poor blast performance	Follow manufacturer's recommendations on compatibility of initiating systems with explosives	Drill and Blast Coordinator Drill and Blast Engineer

Primary Cause 5: On-bench/site practices			
Potential Cause	Likely indicators	Control measures	Responsibilities
Use of out of specification manufactured bulk explosives	- Intermittent NOx fume - No column rise - Stock take of raw materials use out of line with manufacturing requirements - No MPU calibration records - No QC records on pumpable explosive - Poor blast performance	Review quality process controls during the loading and through post blast audits	Drill and Blast Coordinator Drill and Blast Engineer Explosive Supplier MPU Operator
Inadequate mixing of raw materials	- Frequent NOx fume in all areas associated with loading from a specific delivery system - Product appearance abnormal	Visual check	Shotfirer Bench Hand MPU Operator
		Density check	MPU Operator Shotfirer
Delivery system metering incorrectly (on bench incorrect manufacture of product)	- Increased frequency of NOx - All blasts and all locations utilising explosive product(s) that incorporate a specific precursor - Inconsistent blast performance	Regular calibration of metering systems	MPU Operator MPU owner
		Quality control of explosive products conducted in accordance with manufacturer's recommendations	Explosive Supplier MPU Operator
Delivery system settings for explosive product delivery overridden		Do not override calibration settings on manufacturing systems	Drill and Blast Coordinator MPU owner MPU Operator



Primary Cause 5: On-bench/site practices			
Potential Cause	Likely indicators	Control measures	Responsibilities
Explosive product incorrectly loaded into blast hole	- Intermittent NO_x fume - Poor blast performance	All blast crew to be trained in the correct method of delivery of all products	Shotfirer Bench Hand MPU Operator
Incorrect product used wet/dry	- Intermittent NO_x fume - Poor blast performance - Misfires	All blast crew to be trained in the potential consequences of incorrect product usage	Shotfirer Bench Hand MPU Operator
MPU operator not yet competent	- Intermittent NO_x fume - Misfires - Inconsistent blast performance	- Ensure only competent personnel operate MPU's unsupervised - Conduct Safe Task Observations to ensure compliance with procedures	Drill and Blast Coordinator MPU Owner
Excess product loaded	Intermittent NO_x fume	All blast crew to be trained in the potential consequences of failing to ensure the correct quantity of product is loaded	Drill and Blast Coordinator MPU Operator Shotfirer
Rainfall on a sleeping shot.	- Slumping of holes - Poor blast performance	Review rainfall forecasts for planned sleep time of shot and select explosive products according to manufacturer's recommendations.	Mine Operations Manager Drill and Blast Coordinator Drill and Blast Engineer Shotfirer Explosive Supplier
		Minimise sleep time for dry blast hole explosive products if rain is predicted. Consider early firing of blast.	Mine Operations Manager Drill and Blast Coordinator Shotfirer
		Bench design for water runoff/or drainage	Drill and Blast Coordinator Drill and Blast Engineer Mine Operations Manager
		Seal top of blast holes to prevent water ingress e.g. with gas bag	Drill and Blast Coordinator Drill and Blast Engineer Shotfirer
		Consider removing water affected product	Mine Operations Manager Drill and Blast Coordinator Drill and Blast Engineer Explosive Supplier
Explosive product seeping into cracks	- Slumping - Intermittent NO_x fume	Follow manufacturer's recommendations on	Drill and Blast Coordinator Shotfirer



Primary Cause 5: On-bench/site practices			
Potential Cause	Likely indicators	Control measures	Responsibilities
	- In specific areas known to contain a high incidence of faulted/fractured ground only - Unexpected blast performance	explosive product selection	MPU Operator
	Hole loading larger than planned	Use blast hole liners	Drill and Blast Coordinator Drill and Blast Engineer Shotfirer
		Maintenance of accurate drill records which are used to map geological conditions	Driller Drill and Blast Coordinator Geologist Drill and Blast Engineer
		Record and monitor blast holes which have slumped or require excessive explosive product to reach stemming height, but where water is not present	Shotfirer MPU Operator Bench Hand
Dynamic water in holes	- Intermittent NO_x fume - Slumped blast holes - Usually when using non-water-resistant explosive products	Minimise sleep time of shot	Drill and Blast Coordinator Mine Operations manager Drill and Blast Engineer Shotfirer
	Poor blast performance	Follow manufacturer's recommendations on explosive product selection to reflect blasthole QAQC	Drill and Blast Coordinator Drill and Blast Engineer Shotfirer
		Measure recharge rates if de-watering, -and choose explosive products according to manufacturer's recommendations	Drill and Blast Coordinator Drill and Blast Engineer Shotfirer MPU Operator Bench Hand / De-waterer Operator
		Record slumped holes and use this information to build understanding of pit hydrology	Drill and Blast Engineer Shotfirer MPU Operator Bench Hand/ De-waterer Operator Geologist
		Understand hydrology of pit and plan blasting to avoid interaction	Drill and Blast Coordinator



Primary Cause 5: On-bench/site practices			
Potential Cause	Likely indicators	Control measures	Responsibilities
		between explosives and dynamic water (either natural or from other pit operations)	Drill and Blast Engineer Shotfirer Geologist
		Use hole liners	Drill and Blast Coordinator Drill and Blast Engineer Shotfirer
Moisture in clay	- Frequent NOx fume - In clay strata only	Consider water resistant explosive products and how this may impact sleep time.	Drill and Blast Coordinator Drill and Blast Engineer Shotfirer
		Hole liners may be required for ANFO.	Drill and Blast Coordinator Drill and Blast Engineer Shotfirer
Blast hole deterioration between drilling and loading	- Intermittent NOx fume - Traceable to specific geological areas - Inconsistent column rise while loading	Minimise time between drilling and loading	Drill and Blast Coordinator Drill and Blast Engineer Mine Planning Engineer
		Use blast hole cameras to ascertain hole condition in critical areas	Explosive Supplier Blast Crew
		Use hole savers	Drill and Blast Coordinator Drill and Blast Engineer Shotfirer
		Mine planning to ensure benches are unaffected by backbreak from earlier blasts, for example presplits, buffers etc.	Mine Operations Manager Drill and Blast Coordinator Drill and Blast Engineer Mine Planning Engineer
		Optimise drilling practices to minimise hole damage though rock cracking etc.	Drill and Blast Coordinator Driller
Contamination of explosives (bottom of hole, stemming section))	- Intermittent NOx fume - Blasts containing wet/dewatered blast holes only Dynamic water	Load wet blast holes first and dip remaining holes prior to loading. Adjust explosive product selection according to manufacturer's recommendations.	Drill and Blast Coordinator Drill and Blast Engineer Shotfirer Bench Hand



Primary Cause 5: On-bench/site practices			
Potential Cause	Likely indicators	Control measures	Responsibilities
		Eliminate top loading into wet blast holes	Shotfirer Bench Hand MPU Operator
		Ensure all primers are positioned in undiluted explosive product	Shotfirer Bench Hand
		Use of gas bags in dewatered blast holes	Drill and Blast Coordinator Drill and Blast Engineer Shotfirer Bench Hand
		Seal top of explosives column to prevent water ingress	Drill and Blast Coordinator Drill and Blast Engineer Shotfirer Bench Hand



Primary Cause 5: On-bench/site practices			
Potential Cause	Likely indicators	Control measures	Responsibilities
		Use hole liners	Drill and Blast Coordinator Drill and Blast Engineer Shotfirer Bench Hand
		Reduce excessive hose lubrication during charging	MPU Operator Shotfirer Bench Hand
		Measure water recharge rate after dewatering.	Shotfirer Bench Hand
		Adjust explosive product selection according to manufacturer's recommendations for wet environment.	Drill and Blast Coordinator Drill and Blast Engineer Shotfirer Bench Hand MPU Operator Explosive Supplier
		Decking to eliminate contact with known dynamic water	Drill and Blast Coordinator Drill and Blast Engineer Shotfirer Bench Hand
		Select explosive products for wet blast holes according to manufacturer's recommendations.	Drill and Blast Coordinator Explosive Supplier Drill and Blast Engineer
		Verify correct hose handling practices are in place	Shotfirer MPU Operator Bench Hand
		Load blast holes on the lower RL last where practical	Shotfirer Bench Hand Drill and Blast Engineer
		Use suitable, safe dewatering techniques	Shotfirer Bench Hand
		Minimize sleep time	Mine Operations Manager Drill and Blast Coordinator Drill and Blast Engineer Shotfirer
		Scan the floor and create the heat map	Mine surveyor Drill and Blast Engineer



Primary Cause 6: Blasting Personnel			
Potential Cause	Likely indicators	Control measures	Responsibilities
Lack of an understanding of the possible causes, and prevention techniques, of fume amongst blasting personnel (shotfirers, MPU operators, Drill and Blast Engineer s)	Frequent NOx fume	All blast crew to be trained in the potential consequences of incorrect product usage	Drill and Blast Coordinator Drill and Blast Engineer Shotfirer MPU Operator Explosive supplier
Blasting personnel not consistent in defining dry and wet bench conditions	Frequent NOx fume	All blast crew to be trained in the potential consequences of incorrect product usage	Drill and Blast Coordinator Drill and Blast Engineer Shotfirer MPU Operator
Blasting personnel not following site SOPs	NOx Fume	All the Blast crew should be site inducted	Drill and Blast Coordinator Blast Crew HST

APPENDIX 2 – INFORMATION FOR TREATING MEDICAL STAFF

This is a sample of the information that should be provided to a treating doctor. Organisation should ensure that regular meetings are held with the local medical doctors that would be treating their personnel for exposures to oxides of nitrogen and other typical injuries or exposures that could be expected from their employees.

Information for Treating Doctor

Dear Doctor

This patient has been exposed to NOx. This is a gas usually produced on mines after the use of explosives. NOx consists of multiple combinations of nitrogen and oxygen (N₂O, NO, NO₂, N₂O₄, N₂O₃, N₂O₅). Nitrogen Dioxide (NO₂) is the principal hazardous nitrous fume.

NOx irritates the eyes and mucous membranes primarily by dissolving on contact with moisture and forming a mixture of nitric and nitrous acids. But this is not the only way injury can occur.

Inhalation results in both respiratory tract irritation and pulmonary oedema. High-level exposure can cause methemoglobinemia. Some people, particularly asthmatics, can experience significant bronchospasm at very low concentrations.

The following effects are commonly encountered after NOx exposure:

Acute

- Cough
- Shortness of breath
- irritations of the mucous membranes of the eyes, nose and throat.

Short Term

- Pulmonary oedema, which may be delayed from 4 to 12 hours.

Medium Term

- RADS (Reactive Airways Dysfunction Syndrome)
- in rare cases, bronchiolitis obliterans, which may take from 2 to 6 weeks to appear.



Long Term

- Chronic respiratory insufficiency.

High-level exposure, particularly associated with methemoglobinemia, can cause chest pain, cyanosis and shortness of breath, tachypnoea and tachycardia. Deaths have been reported after exposure and are usually delayed. Even non-irritant concentrations of NO_x may cause pulmonary oedema. Symptoms of pulmonary oedema often show until a few hours after exposure and are aggravated by physical effort.

Before transfer to you, the patient should have been advised to rest and, if any respiratory symptoms were present, should have been administered oxygen.

The patient will need to be treated symptomatically, but as a base line it is suggested that the following may be required:

- spirometry
- chest x-ray
- methaemoglobin estimation.

Because of the risk of delayed onset pulmonary oedema, it is recommended that as a precaution the patient be observed for up to 12 hours. As no specific antidote for NO_x exists, symptoms will have to be treated on their merits.

Information provided by Dr Vern Madden, Health Advantage Toowoomba, Queensland, Australia

APPENDIX 3 – NOX RATING SCALE

The following table together with the Field Colour Chart on the next page details how NO_x fumes from a surface blast can be assessed (provided by AEISG).

LEVEL	TYPICAL APPEARANCE
Level Zero No fume	 A photograph showing a clear, bright landscape with a blue sky and green vegetation, indicating no visible fumes.
Level One Fume	 A photograph showing a low, dense, yellowish-brown fume cloud rising from the ground, partially obscuring the background.
Level Two Minor yellow/orange fume	 A photograph showing a more significant, higher, and more intense yellowish-orange fume cloud rising from the ground, with a darker sky above.



Level 3 Moderate orange fume	
Level 4 Significant orange fume	
Level 5 Major red/purple fume	

APPENDIX 4 - FIELD COLOUR CHART

Assessing the amount of NO_x produced from a blast will depend on the distance the observer is from the blast and the prevailing weather conditions. The Field Colour Chart can be used to assess the level of NO_x that is produced in a surface blast. Refer to the VUL-TAR-001-Post-Blast-Fumes-TARP for responses especially for the Level 2 and 3 when the fume event has breached the FMZ or wedges.

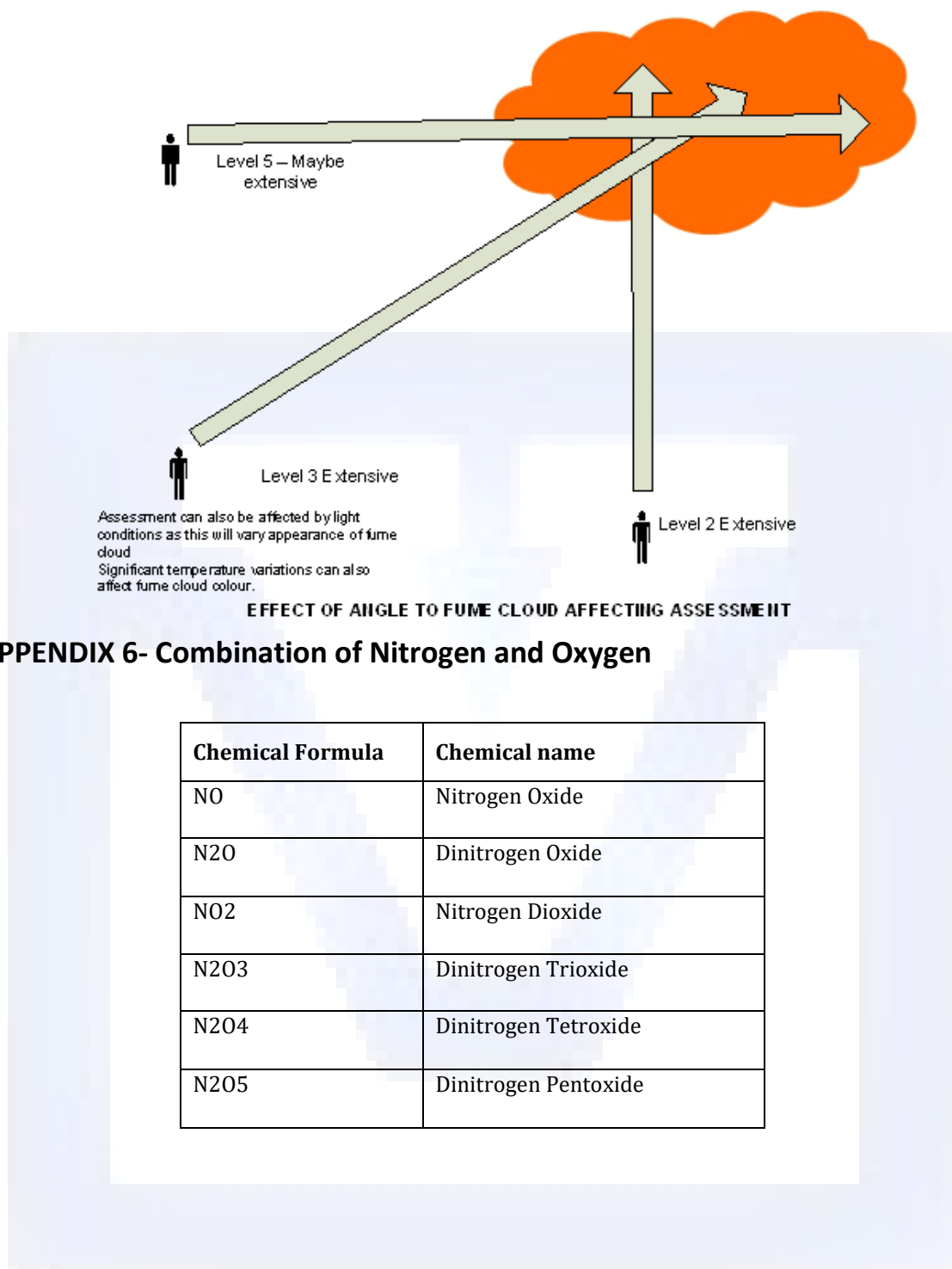
Pantone colour numbers have been included in the Field Colour Chart to ensure colours will always be produced correctly thereby ensuring a reasonable level of standardisation in reporting fume events across the mining industry.

LEVEL	COLOUR	PANTONE NUMBER
Level 0 No Fume		Warm Grey 1C (RGB 244, 222, 217)
Level 1 Fume		Pantone 155C (RGB 244, 219, 170)
Level 2 Minor yellow/orange fume		Pantone 157C (RGB 237, 160, 79)
Level 3 Moderate orange fume		Pantone 158C (RGB 232, 117, 17)
Level 4 Significant orange fume		Pantone 1525C (RGB 181, 84, 0)
Level 5 Major red/purple fume		Pantone 161C (RGB 99, 58, 17)

APPENDIX 5 - OBSERVATION ISSUES

The angle of the person to the fume event will influence the assessment. Where possible and without placing persons in the patch of a fume cloud there should be a number of observers to record the level. This can be moderated to give a more accurate indication of the cloud.

The issue is that the observer position and fume cloud may influence the rating given.





12. REFERENCES

- AEISG Code of Practice Storage & Handling of UN3375
- Coal Mining Safety and Health Act 1999 (Qld)
- Coal Mining Safety and Health Regulation 2017 (Qld)
- Broad Brush Risk Assessment- Vulcan Project
- VUL-RSK-116- Explosives Management
- VUL-TAR-001-Post Blast Fumes
- Explosive Information Bulletin 41 & 7
- Explosive Act 1999
- Explosives Regulation 2017
- AS4326 The Storage & Handling of Oxidising Agents
- AS2187 Explosives- Storage, Transport and Use storage
- AS4145 Locksets and Hardware for Doors and Windows

13. DOCUMENT CONTROL

Version	Date	Description	Document Controller
01	03/02/2026	Document Development & Formatting	Kelly Jensen



Annex A

Role	Pre requisite	Site Requirements	Authorities
Shot firer	-Current QLD Shotfirers Licence -RIIBLA301-Conduct Shotfiring -RIIBLA205A-Store, Handle & Transport	Competent in: -All Explosives SOPs & SWIs -VUL-APP-020 Shotfirer	To conduct Shotfiring activities at VUL Open Cut
Support shot firer	-RIIBLA201 Support Shotfiring -RIIBLA205 Store Handle & Transport -Explosive Security Clearance	-All Explosives SOPs & SWIs -VUL-APP-021 Assistant Shotfirer	To conduct Support Shotfiring activities @ VUL Open Cut under Shotfirer's direction
Magazine Keeper	-Current QLD Shotfirer's Licence -RIIBLA301-Conduct Shotfiring -RIIBLA205A-Store, Handle & Transport	-All Explosives SOPs & SWIs -Appointed site Shotfirer -VUL-APP-022 Magazine Keeper	To access and manage IE / HE stock in explosives magazine
Magazine Compound Access	-Current QLD Shotfirer's Licence -RIIBLA301-Conduct Shotfiring -RIIBLA205A-Store, Handle & Transport - RIIBLA201 Support Shotfiring (to support shotfirer)	-All Explosives SOPs & SWPs -Either Appointed Magazine Keeper or accompanied by one	Unsupervised access to and manage IE / HE stock in explosives magazine.
Explosives Receiver	-Current QLD Shotfirers Licence -RIIBLA301-Conduct Shotfiring -RIIBLA205A-Store, Handle & Transport	-All Explosives SOPs & SWPs -Appointed Magazine Keeper	To access and manage IE / HE stock in explosives magazine. To receive IE / HE stock from Explosives supplier