RAVENSWORTH
OPEN CUT

GLENCORE

Post Blast Fume Management Procedure

Number: RAVCX307024981-4595
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Table of Contents

1. Purpose

The purpose of this document is to outline mitigation and management measures to minimise post blast fume emissions from blasting and implement best practice air quality management, including all reasonable and feasible measures to minimise off-site post blast fume emissions generated by the Ravensworth Operations, as required by Condition 15(a) and Condition 23(a), Schedule 3 of PA 09_0176.

The procedure also details the appropriate emergency response to be instigated where a person believes they have been exposed to post blast fume.

2. Background

Blast fume is a product of (incomplete) combustion from a blast. The products of combustion from a blast may include oxides of nitrogen, ammonia, nitric acid, carbon monoxide and carbon dioxide. These gases are often referred to as “fume”. Nitrogen dioxide is visible as a reddish brown colour - the other products are not visible.

Post blast fume is composed of toxic gases (including NOx) which can be released into the atmosphere in significant quantities from blasting operations. Exposure to even low concentrations can pose a serious health risk. Fume can enter the body by inhalation or contact with eyes and skin. Exposure to nitrogen dioxide can result in delayed health effects that may be potentially life threatening, even though the exposed person may at first appear relatively unaffected. For this reason, anyone who has been exposed to NOx should undergo an immediate medical assessment and a continued period of observation at the advice of the treating doctor.

3. Potential Causes and Management Options

A number of causes that may contribute to the occurrence of post blast fume events have been identified and are sometimes unavoidable due to a variety of reasons (Australian Explosives Industry Safety Group 2011). These causes include:

- Explosive Formulation and Quality Assurance
- Explosives Product Selection
- On Bench Practices (e.g. sleep time, blast hole water conditions, dewatering etc.)
- Weather and Climate
- Geology of the Drill and Blast Zone
- Inappropriate Blast Design
- Contamination of Blast Zone (e.g. explosives mixing with drilling muds / sediment in the drill hole)
- Incorrect priming of blast holes
- Inadequate or inconsistent application of established procedures.

Appendix A -contains a detailed list of the potential causes of post-blast fume, with likely indicators to aid in identification of causes and specific management actions for each.

The fault tree analysis (**Figure 2.1**) can be used by those responsible for blasts in ensuring appropriate steps are taken in the design, loading and firing of the blast to minimise the likelihood of generating fume from the blast.

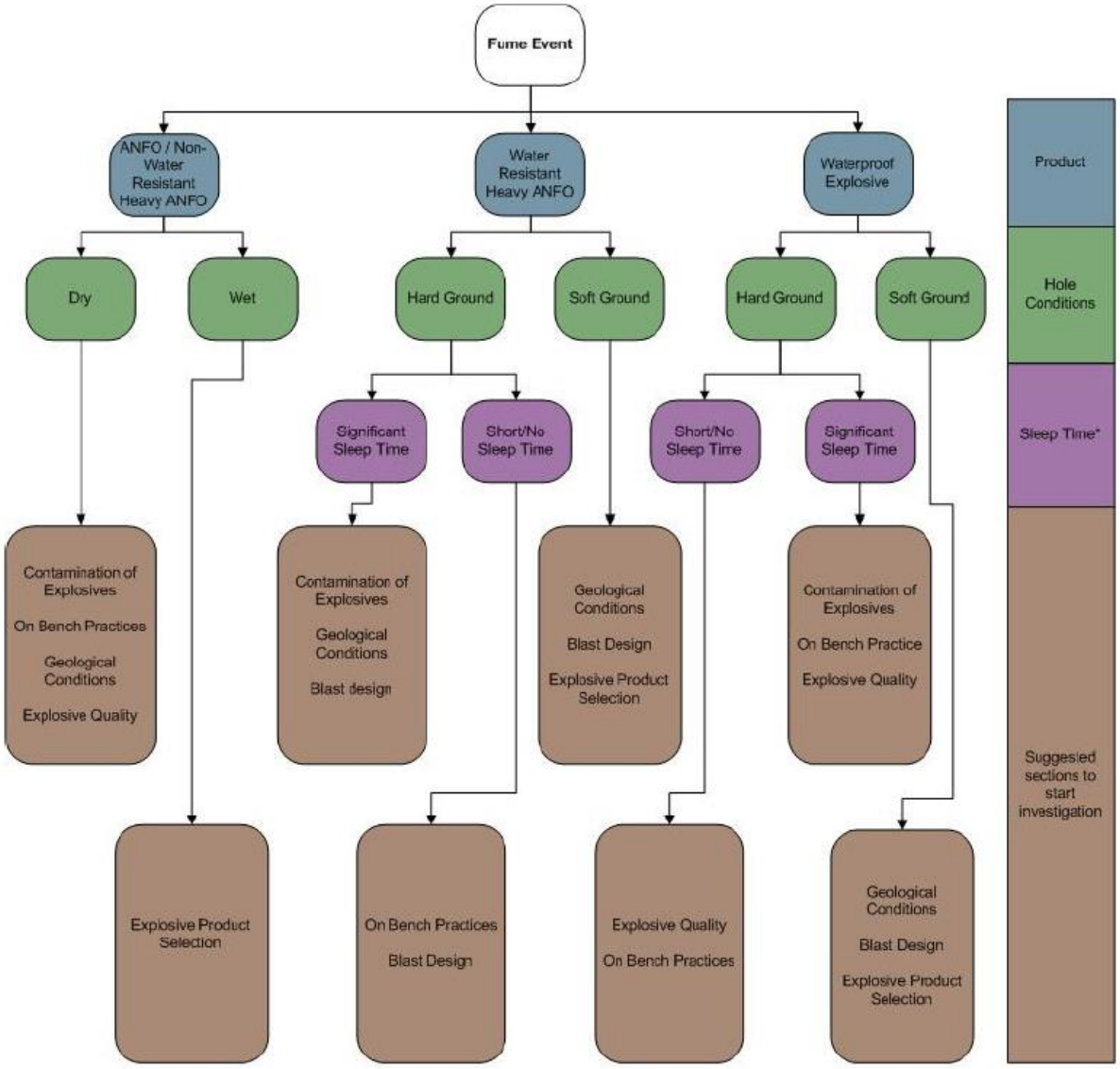

Figure 3.1 Fault Tree Analysis

Note: Reference to short sleep or significant sleep in this Fault Tree does not refer to the explosives manufacturers recommended sleep time, but rather is a subjective term aimed at differentiating between a load and shoot blast and one which is designed to sleep for a period of time. It recognises that there is a correlation between increased sleep time and the generation of NOx gases from blasting.

As a guide for the Fault Tree Analysis only, a time of less than 3 days is considered a short sleep time, however conditions vary and consideration should only be given to the adverse impacts longer sleep times can have on loaded blast holes.

3.1 Blast Pattern Design

Fume considerations for blast design are outlined in *RAVOC-258458278-1773 – Drill and Blast Pattern Design*. These include consideration for;

- Geology;
- Product selection and loading arrangement;
- Timing;

- Sleep times; and
- Weather prior to loading

3.2 Drilling

Drilling practices for fume mitigation are outlined in *RAVOC-258458278-176* – Drilling Procedure. These include consideration for;

- Geological anomalies – identification of cracks, voids etc.;
- Drill hole positioning – correct hole location;
- Drill hole preservation – hole savers and gas bags; and
- Bench preparation – drainage, removal of fill etc.

3.3 Blast Hole Loading

Loading practices to mitigate and manage fume are outlined in *RAVOC-258458278-2560* – Loading Blast Holes. These include;

- Classification of blast holes – wet or dry;
- Product changes; and
- Loading techniques – pumping wet product, density checks, sequence etc.

3.4 Firing the shot

Fume considerations for firing the shot are outlined in *RAVOC-258458278-2566 - Tie Up, Clearance and Firing of Blasts Procedure*. These include;

- Blast clearance zones;
- Weather conditions;
- Early firing; and
- Red zone blasting and stakeholder considerations

4. Post-blast Fume Recording and Reporting

Post blast fume is categorised using the Australian Explosives Industry and Safety Group (AESIG) (2011) Visual NOx Gases Rating Scale (**Figure 1**). Assessing the amount of NOx gases produced from a blast will depend on the distance the observer is from the blast and the prevailing weather conditions.
The intensity of the NOx gases produced in a blast should be measured on a simple scale from 0 to 5 based on the table shown in Figure 1. The extent of the NOx gases also needs to be assessed and this should be done on a simple scale from A to C where:

- A = Localised (i.e. NOx Gases localised across only a few blast holes)
- B = Medium (i.e. NOx Gases from up to 50% of blast holes in the shot)
- C = Extensive (i.e. Extensive generation of NOx Gases across the whole blast)

In accordance with *RAVOC-258458278-1773* – Drill and Blast Pattern Design, the details of every blast, including the post blast fume rating, are to be recorded. All blasts are also to be video recorded (until fume dissipates or

leaves the field of view if fixed) by the Drill and Blast team, and all videos are to be stored on the server for at least one year.

In the event of blast fume having a rating of ≥4, or an event that is rated 3 and leaves the site boundary, the E&C Manager must be notified immediately (refer to Environmental Incident Category Matrix (GCAA-625378177-9992)).

In addition to this, a record of blast time, wind conditions and the video captured shall be forwarded to the E&C Manager for consideration and the Ravensworth Operations Pollution Incident Response Management Plan (PIRMP) will be implemented. As required by Section 5 of the PIRMP, notification of the following authorities (**Table 4.1**) is to be undertaken immediately.

Table 4.1 PIRMP Notification Requirements

Agency	Contact details
Emergency	Ph: 000 (To be contacted ONLY, and first, if the incident presents an immediate threat to human health or property and emergency services are required)
EPA	Ph: 131 555
Ministry of Health	Ph: (02) 4924 6477 (ask for Public Health Officer on call)
Safe Work NSW	Ph: 131050
Singleton Council	Ph: (02) 6578 7290 (office hours) or (02) 6572 1400 (after hours)
Fire and Rescue	Ph: 1300 729 579
Department of Planning and Environment (DPE)	Ph: (02) 6575 3413
Department of Regional NSW – Resources Regulator	Ph: (02) 4063 6714

Refer to *RAVOC-1007099517-67 Ravensworth Open Cut PIRMP* for further information on the PIRMP requirements.

The Environment and Community Department will notify the DPE Singleton Compliance Office's Incident Reporting Line on (02) 65753405 of any blast producing post blast fume that rates 3 at its highest extent and leaves the site (see **Appendix B** for site boundary), and any blast that rates 4 or 5, whether it leaves site or not.

If requested a formal incident report will be prepared. Within this report the quantity and type of explosive, the number of blast holes and any other details relevant to identifying the cause of the blast should be included.

Table 4.2 and **Table 4.3** detail how NOx gases from a blast will be assessed.

Table 4.2 Visual NOx Gases Rating Scale

Level	Typical Appearance
Level 0 No NOx gas	
Level 1 Slight NOx gas	
1A Localised	
1B Medium	
1C Extensive	
Level 2 Minor yellow/orange gas	
2A Localised	
2B Medium	
2C Extensive	
Level 3 Orange gas	
3A Localised	
3B Medium	
3C Extensive	
Level 4 Orange/red gas	
4A Localised	
4B Medium	
4C Extensive	
Level 5 Red/purple gas	
5A Localised	
5B Medium	
5C Extensive	

Pantone colour numbers have been included in the following Field Colour Chart (**Table 4.3**) to ensure colours will be produced correctly in reporting NOx gas events.

Table 4.3 Field Colour Chart

Level	Colour	Pantone Number
Level 0 No NOx gas		Warm Grey 1C (RGB 244, 222, 217)
Level 1 Slight NOx gas		Pantone 155C (RGB 244, 219, 170)
Level 2 Minor yellow/orange gas		Pantone 157C (RGB 237, 160, 79)
Level 3 Orange gas		Pantone 158C (RGB 232, 117, 17)
Level 4 Orange/red gas		Pantone 1525C (RGB 181, 84, 0)
Level 5 Red/purple gases		Pantone 161C (RGB 99, 58, 17)

5. Responding to Personal Exposure to Fume

If exposure to post blast fume is believed to have, or has the potential to impact sensitive receivers, Ravensworth Operations will contact these receivers. Typically these will be the same receivers contacted regarding blasting times. Ravensworth Operations will provide instructions on how to manage, limit and mitigate their exposure to a post blast fume event.

If Ravensworth Operations employees or contractors have the potential to be impacted by exposure to post blast fume, directions will be provided by sentries and/ or the Drill and Blast Superintendent to limit and mitigate exposure.

The steps below detail the protocol that is to be followed in the event that a person believes that they may have been exposed to post blast fume.

Step 1

A person who believes they are being exposed to post blast fume should move to a safe location into a fresh air environment and warn others in the area that may become exposed where possible.

Notify their supervisor immediately or if warranted declare an emergency in accordance with RAVOC-258458278-8391 Emergency Response Management Plan.

- D.R.S.A.B.C.D manage priorities
- Rest the patient to avoid anxiety
- Provide high concentration oxygen therapy to the patient
- The patient should not be given food or fluids
- Assess the patient and record baseline observation i.e. respiratory rate and effort, skin colour etc.

Step 2

- Call for an ambulance and advise of a suspected post blast fume exposure, the symptoms of the patient will determine if the ambulance is called using 000 or the ambulance bookings number.
- Notify the Health and Safety Department so a representative can attend the hospital and assist the patient as required.
- Gather a copy of RAVOC-258458278-3056 – Post Blast Fume Doctor Information for the patient to take with them when they attend the hospital
- Copies of RAVOC-258458278-3056 – Post Blast Fume Doctor Information are located in the ROC First Aid Room.

Step 3

- The patient must not be left alone or allowed to drive themselves to the medical facility. Repeat baseline observations every 20-30 minutes should be maintained.

Step 4

- The patient or accompanying ambulance officer will hand over the RAVOC-258458278-3056 – Post Blast Fume Doctor Information to the attending medical officer for their reference and assessment. A medical check of the patient will be performed, and if considered necessary, the doctor may require the person to be admitted for observation if required. A ROC representative will then advise the injured person's family of the situation.

Step 5

- If following the medical examination and investigations the patient is not admitted they will be driven back to work.

Step 6

- Upon arrival back at work, the person should report to their supervisor and advise them of the results of the investigation.

6. Document Information

6.1 Related Documents

Table 6.1 Related Documents

Number	Title
GCAA-625378177-9975	GCAA 11.12 Blast Management
RAVOC-258458278-1773	Drill and Blast Pattern Design
RAVOC-258458278-3056	Post Blast Fume Doctor Information
RAVOC-1007099517-67	Ravensworth Open Cut Pollution Incident Response Management Plan
RAVOC-258458278-176	Drilling Procedure
RAVOC-1536591325-4645	Pre-blasting Environmental Assessment
GCAA-625378177-9992	GCAA 6.0 Incident Standard
RAVOC-258458278-2560	Loading Blast Holes
RAVOC-258458278-8391	Emergency Response Management Plan

6.2 Reference Information

Table 6.2 Reference Information

Reference	Title
AESIG Code 2011	Australian Explosives Industry and Safety Group, Inc. (AEISG) 2011. Code of Practice: Prevention and Management of Blast Generated NOx Gases in Surface Blasting. Edition 1, published June 2011.

6.3 Change Information

Full details of the document history are recorded in the document control register, by version. A summary of the current change is provided in the table below.

Table 6.3 Change Information Summary

Version	Date	Reviewer	Change Summary
1	28/03/13	Production	New document created to manage post blast fume
2	21/08/14	T Zolnikov	Reviewed to include notification to E&C Manager of fume events. Minor updates after completion of PTO by T Zolnikov.
3	17/10/14	E&C	Reviewed document in line with DoPE comments on Blast Management Plan
4	4/12/14	E&C	Updating text to suit current practices. New Glencore template

5	09/01/15	M Gregson	Inclusion of steps to manage personnel exposure (taken from RAV SD PRO 0132 – now obsolete). Removal of Doctor form in appendix (reference made to RAV SD FRM 0033)
6	22/09/15	G Newton	Change of document owner from E&C to Mine Manager
7	01/07/16	B Hubert	Reference to Environmental Incident Standard CAA HSEC STD 0006
8	28/08/17	T Zolnikov	Refered to *RAV MIN PRO 0131 – Drill & Blast Pattern Design* instead of RAV MIN PRO 0047 for blast pattern design. RAV MIN PRO 0047 is redundant.
9	05/10/17	N/A	Republished by migration script – new Sharepoint
10	1/11/20	B Morrison	Reviewed relevance of document and updated to new template. Minor grammatical changes and updated document references.
11	16/09/2022	K Marchant	Updated PIRMP contacts, inclusion of field colour chart and minor formatting

Appendix A - Potential Fume Causes and Management Options

The following table is taken from AEISG (2011) Code of Practice: Prevention and Management of Blast Generated NOx Gases in Surface Blasting.

1. Explosive Formulation and Quality Assurance		
Potential Cause	**Likely Indicators**	**Management Actions**
Explosive product incorrectly formulated	Frequent NOx fume All blasts and all locations utilising a specific explosive product	Explosives formulated to an appropriate oxygen balance to minimise the likelihood of post-blast fume Explosives supplier to test formulations where any change in ingredients
Explosives product change	Frequent NOx gases All new blasts and locations	Supplier to notify user sites of changes to product specifications, Technical Data Sheets, recommendations for use
Inadequate mixing of raw materials	Frequent NOx fume NOx emitted from blast holes loaded from a specific delivery system Product appearance abnormal	Visual check Density check Ensure compliance with supplier's/manufacturer's instructions
Explosive precursors not manufactured to specification	Increased frequency All blasts and all locations utilising explosive product(s) that incorporate a specific precursor	Investigate with supplier of explosive precursors Precursor Supplier/Owner to manage disposal or rectification
Precursor degradation during transport and storage	Intermittent NOx gases Traceable to a precursor which has degraded between manufacture and use	Appropriate storage location and stock rotation management Appropriate transport and transfer of precursors Inspection and/or testing of precursors prior to use in accordance with supplier's recommendations Precursor Supplier/Owner to manage disposal or rectification

Raw material changes	Frequent NOx gases All blasts and locations utilising explosive product(s) that incorporate a specific raw material	Change management procedures in place by suppliers Prior notification to suppliers from site change management systems where precursors are supplied by sites, for example customer-supplied fuels
2. Geological Conditions		
Potential Cause	**Likely Indicators**	**Management Actions**
Lack of relief in weak/soft strata	Frequent NOx gases In specific areas known to contain weak/soft strata only	Understand geology of each shot and design blast (timing and explosive product) to ensure adequate relief in weak/soft strata, for example incorporation of a free face, reduction of powder factor, modified timing etc. Minimise blast size and depth
Inadequate confinement in soft ground	Frequent NOx gases NOx occurs in specific areas known to contain weak/soft strata only	Appropriate explosives product selection – refer to supplier Change design to suit conditions Minimise blast size
Explosive product seeping into cracks	Intermittent NOx gases In specific areas known to contain a high incidence of faulted/fractured ground only	Follow manufacturer's recommendations on explosive product selection Maintenance of accurate drill records which are used to map geological conditions Record and monitor blast holes which are slumped or require excessive explosive product to reach stemming height, but where water is not present
Dynamic water in holes	Intermittent NOx gases Preceded by the observation of slumped blast holes Usually when using non water-resistant explosive products	Minimise or eliminate sleep time of shot e.g. load and shoot Follow manufacturer's recommendations on explosive product selection Record slumped holes and use this information to build understanding of pit hydrology Understand hydrology of pit and plan blasting to minimise interaction and exposure of explosives to dynamic water (either natural or from other pit operations)
Moisture in clay	Frequent NOx gases In clay strata only	Consider water resistant explosive products and how this may impact sleep time. Minimise sleep time e.g. load and shoot

Blast hole wall deterioration between drilling and loading e.g. cracks, voids, hole contraction	Intermittent NOx gases Traceable to specific geological areas	Minimise time between drilling and loading Use hole savers Leaving join ups between patterns to minimise blast damage to adjacent holes.
Chemistry of rock type e.g. limestone	Frequent NOx gases Traceable to specific geological areas	Appropriate explosive product as per manufacturer recommendations
3. Blast Design		
Potential Cause	**Likely Indicators**	**Management Actions**
Explosive desensitisation due to the blast hole depth	Frequent NOx gases In deep holes only	Reduce bench height Ensure adequate relief in deep holes Follow manufacturer's recommendations on explosive product selection and blast design for deep holes, for example decking where appropriate.
Inappropriate priming and/or placement	Intermittent NOx gases Residue product	Follow manufacturer's recommendations on explosive product initiation. Review of the site approved blast design to improve priming.
Mismatch of explosives and rock type	Frequent NOx gases	Appropriate blast design/approval process for site. Communication between user and supplier to determine product suitability for application
Inter-hole explosive desensitisation	Frequent NOx gases Blast holes drilled too close together Blast hole deviations	Change blast design and timing. Product and initiation selection – consult manufacturer/supplier Increased control on drilling with deeper designs
Intra-hole explosive desensitisation in decked blast holes	Frequent NOx gases When using decks only	Appropriate separation of explosive decks e.g. distance, initiation timing. Change design

Initiation of significant explosive quantities in a single blast event	Intensity of post-blast gases proportional to explosives quantity used	Reduce blast size in order to reduce total explosive quantity being initiated in the one blast event Reduce powder factor
4. Explosive Product Selection		
Potential Cause	**Likely Indicators**	**Management Actions**
Non water-resistant explosive products loaded into wet or dewatered holes	Intermittent NOx gases Blasts containing wet/dewatered blast holes only	Follow manufacturer's recommendations on explosive product selection Regular education of bench crew on explosive product recommendations from current supplier Discipline in on-bench practices (refer also to 5. On Bench Practices) Weather forecasts to be obtained and considered Bench design for effective water run-off
Excessive energy in weak/soft strata desensitising adjacent explosive product columns	Frequent NOx gases In specific areas known to contain weak/soft strata only	Understand geology of each shot and design blast (timing and explosive product) to match, for example reduction of powder factor. Follow manufacturer's recommendations on explosive product selection Obtain appropriate technical assistance if required to ensure optimal result
Primer of insufficient strength to initiate explosive column	Frequent NOx gases All blasts using a particular primer type / size	Follow manufacturer's recommendations on compatibility of initiating systems with explosives
Desensitisation of explosive column from in-hole cord initiation	Frequent NOx gases Only in areas where in-hole cord initiation is used	Follow manufacturer's recommendations on compatibility of initiating systems with explosives Minimise use of detonating cord for down the hole initiation wherever possible
Inappropriate explosive product for application	Frequent NOx gases In specific applications	Communication between user and supplier to determine product Suitability for application User to follow supplier's Technical Data Sheets

		Appropriate blast design/approval process for site.
5. Bench Practices		
Potential Cause	**Likely Indicators**	**Management Actions**
Hole condition incorrectly identified	Intermittent NOx gases Only when using non water-resistant explosive products	Dip holes prior to loading when required Record wet, dewatered and dry holes on blast plan and use this information as a basis for explosive product selection Record actual load sheets for each hole Minimise time between dipping and loading, especially in soft and clay strata. Note: Enough time should be allowed for any dynamic water in the hole to be identified If unexpected material is found in drill cuttings the site Geologist / Coal Quality team investigate and communicate back any associated strata changes Minimise sleep time Training/competence of blast crew
Blast not drilled as per plan	Intermittent NOx gases Can be correlated with inaccurately drilled patterns	Maintenance of accurate drilling records and review of blast design if required to compensate for inaccuracies.
Blast not loaded as per blast plan	Intermittent NOx gases Localised or general occurrence	Training/competence of blast crew Effective supervision Communication of loading requirements Record actual loadings e.g. product, quantity, height
6. Contamination of Explosives in the Blast Hole		
Potential Cause	**Likely Indicators**	**Management Actions**
Explosive product mixes with mud/sediment at bottom of hole.	Intermittent NOx gases Blasts containing wet/dewatered blast holes only	Optimise drilling practices to minimise blast hole damage Ensure appropriate loading practices are followed during charging

		Ensure primer is positioned in undiluted explosive product Insert gas bag to separate mud/sediment from explosive product Use blast hole savers Use end of loading hose dispersers to minimise contamination Training/competence of blast crew
Penetration of stemming material into top of explosive column (fluid/pumpable explosive products only)	Intermittent NOx gases Blasts charged with fluid/pumpable explosive products only	Use appropriate stemming material Ensure explosive product is gassed to manufacture to specifications before stemming
Water entrainment in explosive product	Intermittent NOx gases Blasts containing wet/dewatered blast holes only	Verify correct hose handling practices are in place e.g. operator competence, procedures, use explosives supplier's personnel Minimize sleep time
Moisture in ground attacking explosive product	Frequent NOx gases Wet ground occurrence	Explosives product selection Minimise or eliminate sleep time e.g. load and shoot Load wet holes first and dip remaining holes prior to loading. Adjust explosive product selection according to manufacturer's/supplier's recommendations.
Contamination of explosives column by drill cuttings during loading	Intermittent NOx gases	Verify correct hose handling practices are in place e.g. operator competence, procedures etc. Training/competence of blast crew Minimise vehicle contact near blast holes Use hole savers
Rainfall on a sleeping shot.	Intermittent NOx gases Occurs following rainfall Usually when using non water-resistant explosive products	Weather conditions are formally reviewed as part of weekly planning process and based on this decisions are made to; remediate benches for improved drainage, align product selection to likely conditions. Review rainfall forecasts for planned sleep time of shot and select explosive products according to manufacturer's recommendations.

	May be preceded by the observation of slumped blast holes	Minimise sleep time for non-wet blast hole explosive products if rain is predicted. Consider early firing of blast. Bench design for effective water runoff Hole savers/gas bags can be installed to reduce the damage to drill holes from wet weather events

Appendix B - Site Boundary for Post Blast Fume Reporting