BLAST MANAGEMENT PLAN
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<th>Author</th>
<th>Authorised By</th>
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<td>Initial document</td>
<td>T Thompson</td>
<td>Chris Burgess</td>
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<td>2011 Rocglen Extension Project Review</td>
<td>Chris Thomas</td>
<td>Danny Young</td>
<td>June 2013</td>
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<td>Madeline Woodhead</td>
<td>Jill Johnson</td>
<td>November 2015</td>
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<td>Jason Conomos</td>
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ACRONYMS USED THROUGHOUT THIS DOCUMENT

- **AS**: Australian Standard
- **AR**: Annual Review (incorporates former Annual Environmental Management Report)
- **BMP**: Blast Management Plan
- **CCC**: Community Consultative Committee
- **EPA**: Environment Protection Authority
- **DP&E**: Department of Planning and Environment
- **EPL**: Environment Protection Licence
- **GSC**: Gunnedah Shire Council
- **DRG**: Department of Planning and Environment - Division of Resources and Geoscience
- **MIC**: Maximum Instantaneous Charge
- **RCM**: Rocglen Coal Mine
1 INTRODUCTION

The Rocglen Coal Mine (RCM) is located approximately 28km north of Gunnedah and 10km east of the Canyon Coal Mine (formerly Whitehaven) (Figure 1). The mine site covers an area of approximately 460 hectares.

The mine was initially approved on the 15th April 2008 under PA 06_0198 with a minor modification granted in May 2010 to address high wall stability issues. Whitehaven submitted a Project Application, and accompanying Environmental Assessment, under Part 3A of the Environmental Planning and Assessment Act 1979 in March 2010. PA 10_0015 was issued on the 27th September 2011 and allows for additional extraction of up to 5 million tonnes of coal at a maximum recovery rate of 1.5 million tonnes per annum (ie. increased projected life of the operation for coal extraction by up to four years).

A minor modification was approved in November 2014 relating to Coal Transport, a second modification was approved in August 2015 allowing changes to coal reject haulage to the site, and a third modification was approved in February 2017 to allow increased coal haulage during calendar year 2017.

This Blast Management Plan (BMP) has been prepared to ensure that the blasting associated with the mine’s operations are in compliance with criteria stated in PA 10_0015 (as modified) for the RCM. To ensure this, the BMP has been prepared in accordance with Schedule 3, Condition 12 of the approval.

The following sub-sections identify the monitoring locations and the nature of the monitoring equipment to be used, equipment setup and post-blasting procedures as well as blast information analysis and reporting procedures. To ensure this document represents an effective on-site management tool, information on invitations for pre-blasting property inspections and investigations, blasting mitigation measures, blast notification procedures and complaint management procedures are also recorded.

The original BMP was prepared in consultation with the Environment Protection Authority (EPA) on the basis of blasting occurring within the confines of project approval limits, which specifies:

- Blasting may only take place on site between 9am and 5pm Monday to Saturday inclusive, and no blasting is allowed on Sundays, public holidays, or at any other time without the written approval of the Secretary; and

- A maximum of 1 blast a day on site, unless an additional blast is required following a blast misfire.

Information regarding blast management and performance to date is available in the site’s Annual Review.

Responsibilities for blast management actions are defined in Table 1 below:
Table 1 - Blast Management Responsibilities

<table>
<thead>
<tr>
<th>Type</th>
<th>Responsibility</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blast Design</td>
<td>Blast Engineer in conjunction with site surveyor or delegate</td>
<td>To ensure blast design will achieve desired result and compliance requirements</td>
</tr>
<tr>
<td>Blast Notification</td>
<td>Site Clerk or delegate</td>
<td>To provide notice to nearby landholders</td>
</tr>
<tr>
<td>Blast Signs</td>
<td>Shot firers or delegate</td>
<td>To provide notice of blasts on site to passers-by and contractors/site visitors</td>
</tr>
<tr>
<td>Pre-blast checklist</td>
<td>Operations Manager or delegate</td>
<td>To ensure all pre-task checks are complete and in order</td>
</tr>
<tr>
<td>Blast Monitors</td>
<td>Environmental Officer or delegate</td>
<td>Permanent blast monitors in place and calibration and servicing of these</td>
</tr>
<tr>
<td>Blast Monitor Review</td>
<td>Environmental Officer or delegate</td>
<td>To confirm compliance and any post notification requirements</td>
</tr>
<tr>
<td>Incident/Exceedance</td>
<td>Environmental Department</td>
<td>Carry out notification requirements</td>
</tr>
<tr>
<td>response</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Routine Reporting</td>
<td>Environmental Officer or delegate</td>
<td>Annual Review, CCC, monthly EPL reports</td>
</tr>
</tbody>
</table>
Figure 1  Rocglen Coal Mine Location
2 STATUTORY REQUIREMENTS

This Blast Management Plan (BMP) follows the management plan requirements specified in Schedule 5, Condition 2 of PA 10_0015 and complies with the requirements of Schedule 3, Condition 12, which states:

Blast Management Plan

The Proponent shall prepare and implement a Blast Management Plan for the project to the satisfaction of the Secretary. The plan must:

(a) be prepared in consultation with EPA, and be submitted to the Secretary for approval by the end of December 2011;
(b) describe the measures that would be implemented to ensure compliance with the relevant conditions of this approval; and
(c) include a blast monitoring program to evaluate the performance of the project.

In addition, the Project Approval includes the following conditional requirements from Schedule 3 relevant to blast management at the Rocglen site:

5. The Proponent shall ensure that the blasting on site does not cause exceedances of the criteria in Table 3.

Table 3: Blasting criteria

<table>
<thead>
<tr>
<th>Location</th>
<th>Airblast Overpressure dB(Lin Peak)</th>
<th>Ground Vibration (mm/s)</th>
<th>Allowable Exceedance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residence on privately owned land</td>
<td>115</td>
<td>5</td>
<td>5% of the total number of blasts over a period of 12 months</td>
</tr>
<tr>
<td></td>
<td>120</td>
<td>10</td>
<td>0%</td>
</tr>
</tbody>
</table>

However, these criteria do not apply if the Proponent has a written agreement with the relevant landowner to exceed the criteria, and the Proponent has advised the Department in writing of the terms of the agreement.

6. The Proponent shall only carry out blasting on site between 9am and 5pm Monday to Saturday inclusive. No blasting is allowed on Sundays, public holidays or at any other time without the written approval of the Secretary.

7. The Proponent shall not carry out more than one blast a day on site, unless an additional blast is required following a misfire.

Note: A blast may involve a number of explosions within a short period, typically less than 2 minutes.

8. If the Proponent receives a written request from the owner of any privately owned land within 2 kilometres of the approved open cut mining pit on site, or other landowner nominated
by the Secretary, for a property inspection to establish the baseline condition of any buildings, and/or structures on their land, or to have a previous property inspection report updated, then within 2 months of receiving this request the Proponent shall:

(a) Commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Secretary, to:

establish the baseline condition of the buildings and/or structures on the land or update the previous property inspection report; and

identify any measures that should be implemented to minimise the potential blasting impacts of the project on these buildings and/or structures; and

(b) Give the landowner a copy of the new or updated property inspection report.

9. If the owner of any privately owned land claims that the buildings and/or structures on their land have been damaged as a result of blasting on site, then within 2 months of receiving this claim the Proponent shall:

(a) Commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Secretary, to investigate the claim; and

(b) Give the landowner a copy of the property investigation report.

If this independent property investigation confirms the landowner’s claim, and both parties agree with these findings, then the Proponent shall repair the damages to the satisfaction of the Secretary.

If the Proponent or landowner disagrees with the findings of the independent property investigation, then either party may refer the matter to the Secretary for resolution.

10. The Proponent shall:

(a) Implement best blasting management practice on site to:

- protect the safety of people and livestock in the surrounding area;

- protect public or private property in the surrounding area; and

- minimise the dust and fume emissions of the blasting; and

(b) Operate a suitable system to enable the public to get up to date information on the proposed blasting schedule on site to the satisfaction of the Secretary.

11. The Proponent shall not carry out any blasting on site that is within 500 metres of:

(a) a public road without the approval of Council; and

(b) any land outside the site that is not owned by the Proponent, unless:

- the Proponent has a written agreement with the relevant landowner to allow blasting to be carried out closer to the land, and the Proponent has advised the Secretary, in writing of the terms of this agreement; or

- the Proponent has:

- demonstrated to the satisfaction of the Secretary that the blasting can be carried out closer to the land, without compromising the safety of people or livestock, or damaging
the buildings and/or structures on the land; and - updated the Blast Management Plan to include the specific measures that would be implemented while blasting is being carried out within 500 metres of the land.

16. The Proponent shall:

(a) Implement best practice air quality management on site, including all reasonable and feasible measures to minimise the off-site odour, fume and dust emissions generated by the project, including those generated by any spontaneous combustion on site;

(b) Minimise any visible air pollution from the project;

(c) Minimise the surface disturbance on site; and

(d) Regularly assess the real time air quality monitoring and meteorological forecasting data and relocate, modify, and/or stop operations to ensure compliance with the relevant conditions of this approval to the satisfaction of the Secretary.

Requirements specified in ML 1620, ML 1662 and Environment Protection Licence (EPL 12870) mirror those listed in the Consent and have been referred to in the relevant sections of this Plan.

2.1 Blasting Criteria and Limitations

In accordance with Schedule 3, Condition 5 of PA 10_0015, the airblast overpressure and ground vibration blasting criteria is as shown in Table 2.

<table>
<thead>
<tr>
<th>Location</th>
<th>Airblast overpressure (dB(Lin Peak))</th>
<th>Ground vibration (mm/s)</th>
<th>Allowable exceedance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residence on privately-owned land</td>
<td>115</td>
<td>5</td>
<td>5% of the total number of blasts over a period of 12 months</td>
</tr>
<tr>
<td></td>
<td>120</td>
<td>10</td>
<td>0%</td>
</tr>
</tbody>
</table>

However, these criteria do not apply if RCM has a written agreement with the relevant landowner to exceed the criteria, and RCM has advised the Department in writing of the terms of this agreement.

Furthermore, PA 10_0015 restricts blasting operations to 1 blast per day, unless an additional blast is required following a blast misfire. Blasting operations are carried out between 9am and 5pm Monday to Saturday inclusive.

Blast monitors are located on the properties ‘Surrey’ and ‘Retreat’ and further information can be found in Section 5.1.2.
3 BLASTING CONTROLS AND MANAGEMENT PROCEDURES

3.1 Potential Impacts

The Rocglen Coal Mine Extension Project Environmental Assessment assessed the potential for structural damage from blasting at surrounding company owned/private agreement, and privately owned, properties. The assessment reviewed historical blast monitoring results which show no exceedances of either the applicable ground vibration or blast overpressure criteria at the nearest residences surrounding the Project Site. On this basis, Spectrum Acoustics (2010) concluded that no significant blasting impacts were expected as a result of the Rocglen Extension Project.

All blasting at Rocglen is designed to satisfy relevant environmental and safety criteria with respect to airblast overpressure and ground vibration, initially using conservative predictive models and subsequently using site procedures developed and refined on the basis of operational experience.

3.2 Blast Design

The following blast design controls are used to minimise impacts:

- Blast design and implementation will continue to be undertaken by a suitably qualified blasting engineer and/or experienced and appropriately certified shotfirer.
- Blast design will continue to include the following features to ensure industry standards are met:
  - Ensuring that burden distances and stemming lengths are such that explosion gases are almost completely without energy by the time they emerge into the atmosphere; and
  - Ensuring that charges consistently detonate in carefully designed sequences.
  - Appropriate aggregates for blasthole stemming and nonel delay-type or electronic detonators will be used to initiate charges.
- Whitehaven will continue to analyse meteorological conditions (in particular, but not limited to, wind speed and direction) prior to blasting to avoid times when the potential for impact is heightened, and also endeavour to blast at around midday over the winter period to avoid temperature inversions.

Further to above, all blast design will be undertaken in accordance with internal blast planning design and record keeping procedures.

3.3 Air Vibrations (Overpressure)

Noise (the audible part of the air vibration spectrum) and airblast (the remaining sub-audible part of the air vibration spectrum) generation can be controlled by ensuring that all, or nearly all, of the explosion energy is consumed in fragmenting and displacing the overburden by the
time the gases vent (via the broken burden rock and/or ejected stemming material) into the atmosphere.

This objective is met by ensuring that:

- Blast hole spacing is implemented in accordance with blast design;
- The burden distance and stemming length are carefully selected;
- Appropriate quality materials are used for stemming;
- Charges detonate in the correct sequence and with inter-row delays that provide good progressive release of burden.
- The maximum weight of explosive detonated in a given delay period (the Maximum Instantaneous Charge (MIC)) is limited to conservative and proven levels; and
- Refining these controls on the basis of the blast monitoring program.

### 3.4 Ground Vibrations

When a confined explosive charge detonates, a fraction of the liberated energy is manifested as seismic energy (i.e. as ground vibrations). The magnitude of ground vibrations depends upon:

- The MIC for the blast;
- The distance between the blast and a residence or sensitive structure; and
- The characteristics of the intervening material (rock, soils, geological structures, etc.) through which the ground vibration wave propagates.

Ground vibration is controlled by ensuring:

- The minimum practicable weight of explosive detonates at an instant (i.e. minimising the MIC) by using the maximum number of delay periods in each blast; and
- Most of the energy liberated by the charge(s) on a given delay number is consumed in providing good fragmentation, adequate displacement and/or a loose, highly dig-able muck-pile, rather than in creating ground vibrations (i.e. by ensuring that the burden distance and effective sub-drilling are not too large).

### 3.5 Fume and Other Post-Blast Emissions

Management of post blast fume is undertaken in accordance with Appendix 1.

Blast generated dust will be minimised by ensuring that stemming columns are not ejected for considerable distances into the atmosphere. Stemming column lengths would be such that their ejection velocities are low.
3.6 Road Closures

The limit of open cut mining encroaches within 500 metres of Wean Road in its realigned position. As per the existing 2013 Road Closure Management Plan (originally approved by Gunnedah Shire Council in 2009), the safety of traffic on Wean Road is ensured via the following actions:

- For all blasts within 500 metres of Wean Road, the road will be closed with blast notice boards updated prior to each blast. Road closures will typically occur for a period of up to 10 minutes;
- Following the blast, Whitehaven will inspect the road surface and remove any rock fragments from the road surface prior to re-opening.

4 INSPECTIONS AND NOTIFICATIONS

4.1 Pre-Blasting Inspections

As a requirement of Schedule 3, Condition 19 of PA 06_0198, at the commencement of the mine RCM advised the owners of “Costa Vale”, “Surrey” and “Brolga” of their entitlement to a pre-blasting structural assessment report of their property. The “Surrey” and “Brolga” landowners accepted the offer and were subsequently provided with copies of the completed reports as carried out by Kelley Covey Pty Ltd. In addition, a structural assessment was also completed at the “Dunmohr” property located well outside the required 2km radius from blasting activities at the request of the landholder.

A further inspection of the “Brolga” residence was undertaken in 2012, following request from the landholder.

In accordance with Schedule 4 Condition 1 of PA 10_0015 advice was issued to the “Surrey”, “Brolga” and “Roseberry” residents of their entitlement to an updated structural assessment as discussed in Section 6.1.2.2, and in 2013 property inspections were undertaken at both “Brolga” and “Surrey”, again carried out by Kelley Covey Pty Ltd. Following requests by the landholders, inspections were also undertaken by Kelley Covey Pty Ltd of the “Kahana” property in 2014, and the “Surrey” property in 2016.

In accordance with Schedule 3, Condition 8 of PA 10_0015, if RCM receives a written request from the owner of any privately owned land within 2 kilometres of the approved open cut mining pit on site, or other landholder nominated by the Secretary, for a property inspection to establish the baseline condition of any buildings and/or structures on their land, or to have a previous property inspection report updated, then within 2 months of receiving this request RCM will:

(a) Commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Secretary, to:

- Establish the baseline condition of the buildings and/or structures on the land or update the previous property inspection report;
• Identify any measures that should be implemented to minimise the potential blasting impacts of the project on these buildings and/or structures; and

(b) Give the landowner a copy of the new or updated property inspection report.

4.2 Pre-Blasting Notification

As per PA 10_0015 Statement of Commitments, RCM will provide the proposed blasting schedule to all residents within a 3 kilometre radius of the blast, and any other person who registers an interest, in order to provide advance notice of the date and time of each proposed blast. The only private residents within 3 kilometres of the expanded open cut pit limit is “Roseberry” as all other residences that fall within the 3 kilometre limit are mine-owned.

Notification to the general public about proposed blasting dates and times is provided via a blast notice board near the mine entrance on Wean Road. This will notify passing motorists when the next blast is scheduled. Two additional signs are provided to the north and the south of the mine site on Wean Road to notify motorists of potential road delays between 9am to 5pm, a contact phone number is also provided. A second blast notice board is displayed on the western entrance to notify traffic entering RCM from the Whitehaven haul route of proposed blasting dates and times.

The Road Closure Management Plan, approved by Council in February 2009, and updated in 2018, will continue to be used for blasts within 500m of Wean Road.

Furthermore, RCM will not carry out any blasting within 500 metres of any land outside the site that is not owned by RCM, unless:

• RCM has written agreement with the relevant landholder to allow blasting to be carried out closer to the land, and the proponent has advised the Secretary in writing of the terms of this agreement; or

• RCM has:
  o Demonstrated to the satisfaction of the Secretary that the blasting can be carried out closer to the land, without compromising the safety of people or livestock, or damaging the buildings and/or structures on the land; and
  o Updated this plan to include the specific measures that would be implemented while blasting is being carried out within 500 metres of the land.
5 MONITORING AND REPORTING

5.1 Monitoring Program

5.1.1 Parameters Measured and Monitoring Frequency

PA10_0015 specifies the following monitoring parameters to be monitored at the locations stated in Section 5.1.2. Monitoring must be undertaken for each blast as specified in Table 3.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units of Measure</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airblast Overpressure</td>
<td>DB(Lin Peak)</td>
<td>Every Blast</td>
</tr>
<tr>
<td>Ground Vibration</td>
<td>mm/s</td>
<td>Every Blast</td>
</tr>
</tbody>
</table>

In addition to blast monitoring at the nominated sites, RCM will also inspect the area around the blast for flyrock distribution.

5.1.2 Monitoring Locations

Monitoring is to be conducted at the residences listed in Table 4 and shown in Figure 2. These were identified in the Noise and Vibration Impact Assessment (Spectrum Acoustics 2010) as receivers and will be used to assess compliance and noise criteria.

<table>
<thead>
<tr>
<th>Description of Location</th>
<th>Private Property (yes/no)</th>
<th>Representative Receptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Retreat” residence</td>
<td>Yes</td>
<td>“Retreat”</td>
</tr>
<tr>
<td>“Surrey” residence</td>
<td>Yes</td>
<td>“Surrey”</td>
</tr>
</tbody>
</table>
Figure 2  Blast Monitoring Locations
5.1.3 Permanent Blast Monitors

Permanent blast monitors are established at the “Retreat” and “Surrey” properties to monitor air-blast overpressure (dBL) and peak particle velocity in a radial, vertical, and transverse direction (mm/s), i.e. ground vibration. The unit currently located at “Surrey” was relocated from the “Roseberry” property in February 2017, at the request of the DP&E and EPA. After each blast, information gathered on a blast is downloaded via the internet or wireless download. This information is then analysed by Environmental Officer to check compliance with blasting criteria. The sensors are calibrated annually and serviced according to manufacturer recommendations.

5.2 Reporting

Blast monitoring results will be reported via Community Consultative Committee (CCC) meetings and Annual Reviews.

Reporting of exceedances is discussed in Section 6.1.2.

6 MANAGEMENT OF INCIDENTS, EXCEEDANCES, NON COMPLIANCES AND COMPLAINTS

6.1.1 Blasting Related Incidents

Safety related incidents (such as misfires) will be recorded and managed via the Whitehaven incident management process. Such incidents are managed in accordance with relevant legislation and includes notification to DRG by the site's Manager Mining Engineering. Emergencies, including notifications, will be managed in accordance with WHC processes.

Specifically in relation to blast fume, blasting design gives due thought to fume potential which is considered in product selection. Sentries are also in place during every blast to monitor fume. In the event of a fume incident all relevant agencies will be notified in accordance with Section 6.1.2.1 and any affected landholder, tenant or lessee notified about the incident and informed as to any measures that could minimise the risk of harm.

6.1.2 Blasting Criteria Exceedance

6.1.2.1 Agency Notification

In the event that the monitoring results of a blast identify an exceedance of:

- Peak vector sum velocity (ground vibration) – 5mm/s (ppv); and/or
- Peak overpressure – 115dBL,

RCM will initiate investigation as to the cause of the exceedance.

It is noted that the above criteria are able to be exceeded for up to 5% of the blasts in any 12 month period but not to exceed a:

- Peak vector sum velocity (ground vibration) - 10mm/s (ppv); and/or
• Peak overpressure – 120dBL.

As required by Schedule 5, Condition 6 of PA 10_0015, the Department and any other relevant agencies will be notified as soon as practicable after a blasting related incident occurs. Within 7 days of the incident, an incident report will be submitted to the Department and other relevant agencies.

The Department will be notified of any blast producing post blast fume that rates 3 at its highest extent and leaves the site, and any blast that rates 4 or 5. EPA will be notified, when required by the site’s PIRMP.

Exceedances will also be reported in the blasting discussion in the Annual Review.

6.1.2.2 Landholder Notification

As required by Schedule 4, Condition 1 of PA 10_0015, RCM has notified in writing the owners of “Brolga”, “Surrey”, and “Roseberry” of their entitlement to ask for an inspection to establish the baseline condition of any buildings or structures on their land, or to have a previous property inspection report updated.

Furthermore, as required by Schedule 4 Condition 2(a) of PA 10_0015, as soon as practical after obtaining monitoring results showing an exceedance of the blasting criteria, RCM shall notify the affected landholder and/or tenants in writing of the exceedance, and provide regular monitoring results to each of these parties until the project is complying with the relevant criteria again.

6.1.3 Complaints

Any complaints received will be managed in accordance with complaints management protocol described as follows:

• A publicly advertised telephone complaints line will be in place to receive complaints during operating hours and record complaints at other times.

• Each complaint received will be recorded on a Complaints Register, which will include the following details:
  o The date and time of complaint;
  o Any personal details the complainant wishes to provide or if no such details are provided a note to that effect;
  o The nature of the incident that led to the complaint;
  o The action taken by RCM in relation to the complaint, including any follow-up contact with the complainant; and
  o If no action was taken by RCM, the reason why no action was taken.

• The Environmental Officer will be responsible for ensuring that an initial response is provided within 24 hours of receipt of a complaint (except in the event of complaints recorded when the mine is not operational).
Additional measures will be undertaken as required to address the complaint. This may include visiting the complainant, or inviting the complainant to the mine site.

Once the identified measures are undertaken, the Environmental Officer will sign off on the relevant complaint within the Complaints Register.

If necessary, follow-up monitoring will take place to confirm the source of the complaint is adequately mitigated.

A copy of the Complaints Register will be kept by RCM and made available to the Rocglen Coal Mine Community Consultative Committee (CCC) and the complainant (on request). A summary of complaints received every 12 months will be provided in the Annual Review.

Based on the nature of individual complaints, specific contingency measures may be implemented to the (reasonable) satisfaction of the complainant. The Environmental Officer retains responsibility to ensure that complaints received are properly recorded and addressed appropriately.

6.1.4 Property Investigations

Schedule 3 Condition 9 of PA 10_0015 allows a landholder to request a property investigation if the landholder claims that blasting at RCM has damaged their property. Within 2 months of receiving a request RCM will:

- Commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Secretary, to investigate the claim; and
- Give the landholder a copy of the property investigation report.

If this independent property investigation confirms the landowner’s claim, and both parties agree with these findings, then RCM will repair the damages to the satisfaction of the Secretary. If RCM or the landholder disagrees with the findings of the investigation, then either party may refer the matter to the Secretary for resolution.

6.1.5 Unforeseen Impact Protocol

Unforeseen impacts in relation to blasting are generally considered to be in relation to criteria exceedances or non-compliances (e.g. failure to monitor) and complaints, which are addressed in Section 6.

7 DOCUMENT REVIEW AND CONTINUOUS IMPROVEMENT

This document will be reviewed in accordance with the requirements of Schedule 5 Condition 4 of PA 10_0015. RCM will investigate and implement ways to improve the environmental performance of the project over time. This will be achieved by keeping abreast of best practice in the industry for blast management and monitoring options and reporting on outcomes of blasting in the Annual Review.
Appendix 1  Blast Fume Management Procedure
WHITEHAVEN COAL
BLAST FUME MANAGEMENT
PROCEDURE

<table>
<thead>
<tr>
<th>Approval</th>
<th>Name</th>
<th>Position</th>
<th>Signed</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Document Owner:</td>
<td>Graham Cope</td>
<td>Drill &amp; Blast Manager</td>
<td></td>
<td>18/5/18</td>
</tr>
<tr>
<td>Authorised by:</td>
<td>Nigel Wood</td>
<td>General Manager – Open Cut Operations</td>
<td></td>
<td>18-5-2018</td>
</tr>
</tbody>
</table>

"If it's not safe, don't do it."

UNCONTROLLED COPY WHEN PRINTED.
REFER TO INTRANET FOR LATEST VERSION

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1. **SCOPE**

This procedure outlines the specific blast fume management actions to be implemented at Whitehaven Coal Mines in line with the strategies outlined in the Australian Explosives Industry and Safety Group (AEISG) Code of Practice – Prevention and Management of Blast Generated NOx Gases in Surface Blasting (2011) and WHC-OC-Explosives Control Plan.

The procedure applies to the Project Area and all personnel involved in the purchasing of explosives, blast design, drilling, loading and firing of explosives.

2. **BACKGROUND**

Blasting fumes are comprised of a group of gases known as Oxides of Nitrogen or NOx, a combination of post blast gases which are predominantly nitrogen dioxide, but may also include small amounts of nitrous oxide, nitric oxide, carbon monoxide and carbon dioxide. The two main gases, nitric oxide (NO) and nitrogen dioxide (NO2) are found as by-products in the post-blast gases of ammonium nitrate-based explosives, and are generated in greater quantities where incomplete or low-order detonation occurs. Nitric oxide is colourless, but nitrogen dioxide ranges in colour from yellow to dark red / purple depending on the concentration and size of the gas cloud.

Fume generation can be attributed to a number of primary causes that, either singularly or combined, can be managed to minimise or mitigate the production of NOx. These causes are discussed in detail in the AEISG Code of Practice, and are listed below:-.

1. Explosive formulation and quality assurance
2. Geological conditions
3. Blast design
4. Explosive product selection
5. On bench practices
6. Contamination of explosive in the blast hole

Blasting fumes can be harmful to humans if inhaled in sufficient quantities and/or over a prolonged period of time. These fumes can pose a risk to members of the blast crew and sentries in close proximity, or other mine workers exposed in the event that fumes travel outside the immediate blast clearance area without dispersing. Risks to persons outside the mining area also need to be addressed in the event that large fume clouds travel outside the mine lease on to private or public land.

3. **RESPONSIBILITIES**

Role accountabilities for management of the six AEISG primary causes of fume are provided in detail in Appendix 5.1 and summarised in Table 1.
## Table 1  Role Responsibilities

<table>
<thead>
<tr>
<th>Primary Cause of Blast Fume</th>
<th>Accountable Roles for Management</th>
</tr>
</thead>
</table>
| Cause 1: Explosive formulation and quality assurance | • Explosives supplier  
• Drill and blast engineer  
• Shotfirer  
• Magazine keeper                                                                 |
| Cause 2: Geological conditions                       | • Mine geologist  
• Drill and blast engineer  
• Shotfirer  
• Drill operators                                                                 |
| Cause 3: Blast design                                | • Drill and Blast Engineer  
• Shotfirer                                                                 |
| Cause 4: Explosive product selection                 | • Drill and Blast Engineer  
• Shotfirer                                                                 |
| Cause 5: On bench practices                          | • Drill Supervisor(OCE)  
• Drill Operator  
• Drill and Blast Engineer  
• Shotfirer  
• MMU Operator                                                                 |
| Cause 6: Contamination of explosives in the blast hole| • Drill operator  
• Drill and Blast Engineer  
• Shotfirer  
• MMU Operator                                                                 |

### 4. PROCEDURE

#### 4.1 BLAST DESIGN AND PLANNING

**Design**

Blast designs will be developed to consider:

- Geological constraints such as weak or hard bands of overburden, coal bands and fault.
- Previous Blasts
- Blast performance requirements in terms of fragmentation, heave, dig rates, etc.
- Control of potential blast impacts including flyrock, fume, overpressure, vibration etc.

Blast design mitigations may include:

- Reducing bench heights or ensuring adequate relief in deep holes.
- Selecting explosives products appropriate to the blast design and ground conditions.
- Following manufacturer's recommendations for priming, timing and sleep time of bulk explosives.
- Increasing the level of control and QA/QC checks (ie: bulled holes) on deeper shots.
- Providing appropriate separation of blast holes and explosive decks.
Reducing the powder factor or modifying the timing, depth or size of a blast.

Geology
Where clay or other unfavourable geological conditions are identified, explosive product selection will be modified to suit conditions. When blasting in soft ground, or areas with a history of producing blast fume, increased blast clearance may also be required to ensure the safety of personnel.

Sleep Time
All blasts will be designed and planned to be fired within 5 days of first being loaded. Approval from the Operations Manager is needed for shots requiring longer sleep times up to a maximum of 7 days. The prevailing and forecast weather conditions as well as the Fume Risk rating and manufacturers recommendations will be taken into account when planning the required blast sleep time.

Explosive Selection
Explosives Selection for Fume Mitigation is managed by the drill and blast reconciliation process as defined in the following process model.
Whitehaven Coal - Explosives Selection for Fume Management

Product selection for a specific hole is driven by three inputs:
1. The design explosives density
2. The measured water / wet walls of the hole
3. The defined explosives selection constraints

**Explosives Density**

Design Standards are maintained to ensure blast designs deliver acceptable blast outcomes in relation to blast performance and environmental impacts, including fume.

Design Standards:
- are specific to the defined site geological zones
- specify blast geometry and confinement through depth, face conditions and timing
- define the design targets for blast geometry
- define design powder factor and specify target explosives density.

Note that blast confinement may be defined by design powder factor, blast geometry, face condition and blast timing.
Measured Hole Properties

Blast crews measure holes for depth, standing water and wet walls. This data is entered into the drill and blast database and, with the defined charge rules, is used to select the appropriate explosives.

Explosives Selection Constraints

Explosives selection is constrained by the measured hole properties as shown in the following table:

<table>
<thead>
<tr>
<th>Hole Condition</th>
<th>Wet Wall</th>
<th>Product Profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing Water</td>
<td>Wet Wall</td>
<td>Product Profile</td>
</tr>
<tr>
<td>Dry Holes</td>
<td>Nil</td>
<td>Any product at design density to design Stem height</td>
</tr>
<tr>
<td></td>
<td>&lt;1m*</td>
<td>Bag off toe →</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Any product at design density to design Stem height</td>
</tr>
<tr>
<td>Dewatered Holes</td>
<td>&lt;1m*</td>
<td>Bag off toe →</td>
</tr>
<tr>
<td></td>
<td>Wet wall no recharge</td>
<td>Auger XL60_90/120 to wet wall+cover** →</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Any product at design density to design Stem height</td>
</tr>
<tr>
<td></td>
<td>&lt;1m*</td>
<td>Bag off toe →</td>
</tr>
<tr>
<td></td>
<td>Wet wall low recharge rate &lt;1m/hr</td>
<td>Auger XL60_90/120 to wet wall+cover →</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Any product at design density to design Stem height</td>
</tr>
<tr>
<td>Wet Holes</td>
<td>&lt;1m*</td>
<td>Hose XL70_120 to design Stem height</td>
</tr>
<tr>
<td></td>
<td>&gt;1m*</td>
<td>Hose EX70-120 to design Stem height</td>
</tr>
</tbody>
</table>

*The standing water trigger is dependent on the ground conditions and the number of wet holes in the local area.

"If it’s not safe, don’t do it."
** Cover is the height above the measured wet wall that the water-resistant toe charge is to be loaded to

*** Actual product selected must conform to design density

Management of Explosives Selection

The ongoing management of explosives selection to mitigate fume is managed by the standard reconciliation process. Blast fume outcomes are assessed and recorded in the reconciliation process and trigger a review of both the drill and blast process and the relevant Design Standard.

EXPLOSIVES SUPPLY

Whitehaven Coal has contracted Hanwha Mining Services to supply and load down hole bulk explosive products for all open cut mines.

WHC uses hybrid explosives in addition to generic Explosives which differentiate from standard explosives as the base material used in the manufacture is Ammonium Nitrate Mineral Oil (ANMO) and includes EPS (Expanded Polystyrene balls) to lower the explosive density. XLOAD explosive product range numbering indicates the product density (i.e. XLOAD60-100 = 1.0g/cm³) while Pumped Emulsion product range numbering indicates percentage emulsion (i.e. XLOAD70-120 – 70% Emulsion).

Hanwha have self-calibrated load cells on auger explosive load trucks and implement a QA system to test and confirm the specification of the bulk explosive formulations used.

Technical and Safety Data Sheets of all products used are maintained on site.

4.2. **METEOROLOGICAL CONDITIONS**

- Before each blast, weather conditions will be recorded by the site Environmental Officer in accordance with the Environmental Blast Checklist. Shots will not be fired during adverse weather conditions, unless for safety reasons, or to minimise further deterioration of the product due to extended sleep time.

- Any shot that is fired during adverse weather conditions must be approved by the Operations Manager.

- Relevant parameters for consideration prior to firing a shot will be:
  - Wind speed and direction
  - The presence of a temperature inversion
  - Low continuous cloud cover

- The assessment of weather conditions will use meteorological data in the form of real-time wind speed and direction.

- When wet weather is forecast prior to or during loading of shots, product selection will be adjusted to suit as required.

- If there is a risk of blast fume, the Shotfirer must extend the blast danger zone to allow for the safety of all personnel. This is particularly important if a shot has had an extended sleep time, where water intrusion may have affected the bulk explosive, and when firing misfires.
**OPEN CUT OPERATIONS**

<table>
<thead>
<tr>
<th>Document Owner:</th>
<th>Drill &amp; Blast Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revision Period:</td>
<td>5 Yearly</td>
</tr>
<tr>
<td>Issue:</td>
<td>1</td>
</tr>
<tr>
<td>Last Revision Date:</td>
<td>10/05/2018</td>
</tr>
</tbody>
</table>

### WHC_PRO_OC_BLAST FUME MANAGEMENT

- The Drill and Blast Engineer in association with the Environmental Officer will carry out an Environment Blast Hazard Analysis for each Blast to evaluate the risks associated with dust, fume, vibration and Overpressure. Where there is an identified risk of Fume the site Environmental Officer and the Mining Manager are required to assess the proposed blasting conditions and to approve the firing of the blast.

#### 4.3 ENVIRONMENTAL BLAST HAZARD ANALYSIS

- Between the Weekly Planning Meeting and the day before the blast; the Drill and Blast Engineer/Manager should have sufficient design and information regarding the planned blast to commence the Environmental Blast Hazard Analysis checklist. The Environmental Officer (if absent delegated to Drill and Blast Engineer/Manager or their competent and authorised nominee) will complete the checklist with information about the relevant aspects of the planned blast that will allow a qualitative assessment and analysis of the hazards posed by the blast to the environment and community from the potentially adverse impacts such as dust, overpressure, vibration and fume.

- To complete the Environmental Blast Hazard Analysis checklist; the various blast design, location and weather conditions that must be rated as to whether each has a Negligible, Elevated or Substantial effect on the potential vibration, fume, dust and overpressure hazard of the particular blast being analysed. When a hazard section has been completed; an “Overall Hazard” can be qualitatively calculated for the potential vibration, fume, dust and overpressure potential of the blast by adding up the “Hazard Score” from assigning:
  - the value of 1 to each “Negligible” rating;
  - the value of 2 to each “Elevated” rating; and
  - the value of 3 to each “Substantial” rating.

- If the relevant blast hazard posed is considered “Negligible”; no additional controls are required to be implemented in the blast design or at the time of firing the shot. However, if the hazard is considered “Elevated” or “Substantial”; then additional controls will need to be implemented in the blast design, loading, tie up or at the time of firing and documented in the Environmental Blast Hazard Analysis checklist in the “Additional Controls” column. The Drill and Blast Engineer/ Manager and the Environmental Officer should sign off on the checklist for the agreed hazard rating and the Operations Manager sign off the checklist for the additional controls required for Elevated or Substantial blast hazards (including sleep times greater than 7 days).

#### 4.4 BLAST MONITORING & FUME RATING

For each blast the following monitoring will be carried out:

1. Fixed vibration monitors – measures the peak blast overpressure (DBL) and peak ground vibration (mm/s). Portable blast monitors will be used if the fixed monitors are inoperable.

2. A video record of every blast fired will record the shot initiating, blast movement and post blast fume generation. This will then be reviewed to improve future blasting performance and to further minimise blast fumes, flyrock or vibrations. All records will be kept on site for a minimum of two years.

3. All blasts will be rated by the Shotfirer in conjunction with the Environmental Officer for fume levels on a Scale between 0-5, based on the AEISG CODE (Appendix 5.2), refer section 5.1.4 of Blast Management Plan. In the event that a blast produces fume that rates a 3 at its highest extent and leaves the mine site, or if it rated at 4 or 5, immediate notification will be
provided in accordance with Schedule 5 Condition 8, at the earliest opportunity to the Department of Planning and Environment.

4. An Environmental Blast Checklist will be used for each blast. This includes a notification checklist; pre-blast weather conditions assessment prior to and at the time of the blast (commencing at 5 hours prior to the blast); and a post-blast assessment which includes fume rating.

4.5 **BLASTING WITHIN 500M OF A PUBLIC ROAD OR PROPERTY**

- If blasting is to be carried out within 500m of a public road, the road will be closed for the duration of the blast. The road will be reopened once an inspection has indicated it is free of significant fly-rock and/or dust/fumes as described in WHC-PRO-OC-Blast Clearance and Firing.
- Neighbours and Tenants who may live on a WHC owned property near the blast area will be notified of the planned blasting date and time.
- Should a fume event occur, neighbouring properties in line with the fume cloud will be notified in accordance with the site PIRMP, and if necessary evacuated.
- The date, time and location of the blast/s will be posted on appropriate signs, located on any affected road.

4.6. **BLAST EXCLUSION ZONES AND TIMING**

- Establishment of exclusion zones, refer example in Appendix 5.3, and the time of blasts will be conducted in accordance with the WHC-PRO-OC-Blast Clearance and Firing.
- Blasting will be carried out on the site as per Approval conditions relevant to each individual mine site.

4.7. **TECHNICAL AND SAFETY DATA SHEETS**

- Copies of all relevant Technical and Safety Data sheets shall be supplied to the Drill and Blast Engineer and Shotfirers by the Explosives Manufacturer. Copies will be kept on site for reference.
- The type of explosive product used for individual blasts will be selected to minimise the potential for fume generation.

4.8. **INCIDENT AND HAZARD MANAGEMENT**

- Blast fume incidents will be managed in accordance with the WHC-STD-Incident and Hazard Management which provides a generic process that is to be followed for all health, environment and safety incidents that may occur at WHC.
- In the event of NOx exposure (or suspected exposure) medical assistance should be engaged, and the Medical Advice from the AEISG COP (Appendix 5.4) provided to medical personnel.
- The basic precautions are:
  - No personnel will enter the fume.
  - Personnel will move away from the path of the fume.
- If indoors and the fume is heading towards you, close all windows and doors and stay inside.
- If in a vehicle, wind up windows, close doors, stay inside vehicle and use recirculated air conditioning if possible.
- Those exposed to NOx gases should seek immediate medical treatment and consideration should be given to placing those exposed under observation for at least 24 hours after exposure.

4.9. INVESTIGATION – POST FUME INCIDENT

- Should an excessive blast fume (level 3 or higher that is not localised) be generated from a blast, a fault tree (refer to Figure 1 below) will be used during the ICAM incident investigation to identify contributing factors that caused the excessive blast fume.
- Once the contributing factors have been identified, an appropriate action plan will be developed to mitigate and reduce the generation of fume from future blasts.

![Fault Tree](image_url)

**Figure 1** Fault Tree (Source: AEISG, 2011)
4.10. **REPORTING**

Blast fume reporting includes:-

- All blast fume events (Level 1 and above) are reported as Environmental Incidents;
- Significant blast fume events Level 3 and above are investigated using the ICAM incident investigation method in accordance with WHC_PRO_OC_BLAST FUME MANAGEMENT;
- Blast fume events Level 3 that leave the mine site or Level 4 & 5 fume events are to be reported to DP&E Lead Compliance Officer for the Northern Region immediately.
- All blast fume events leaving the mine site boundary require consideration of the sites Pollution Incident Response Management Plan (PIRMP) regulatory/emergency and community notification protocols.

4.11. **DOCUMENT REVIEWING**

This document will be reviewed, and if necessary revised, every 5 years by the Drill and Blast Manager.

4.12. **EDUCATION AND TRAINING**

- All employees will have a general blast fume awareness session delivered through the induction program or Toolbox Talks.
- Additional education and awareness programs will be provided, on an ongoing basis, for relevant personnel working near blast areas such as sentries and drill and blast contractors. Training for relevant personnel (Drill and Blast Engineer, Shotfirers, Drillers, OCE’s, drill and blast contractors) will be undertaken in accordance with WHC-OC-Training and Competency Management Plan, and covers:
  - The identification and rating of post-blast fumes.
  - The potential health impacts of fume gases.
  - Potential causes of blast fume.
  - Fume mitigating actions as detailed in this procedure.

5. **APPENDICES**

5.6. **NOX GASES CAUSES AND CONTROL MATRIX**

<table>
<thead>
<tr>
<th>Cause 1: Explosive formulation and quality assurance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential Cause</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>Explosive product incorrectly formulated</td>
</tr>
</tbody>
</table>
## Explosives/Precursor supplier to provide relevant Technical Data Sheets and Manufacturing directions.

### Precursor delivered to mine site out of specification
- Traceable to a precursor which has degraded between manufacture and use. Poor blast Performance

- Investigate with supplier of explosive precursors. Precursor supplier to provide relevant Technical Data Sheets and Manufacturing directions.

- Explosive Supplier

### Inadequate mixing of raw materials
- 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 supplier to provide QA reports on testing

- Explosive Supplier
- Shotfirer

### Product past use by date
- Difficulty achieving final density.
- Separation
- Crystallising
- Fines
- Colour variation
- Poor blast performance

- Once per truck to ensure the product is within the manufacturers specification i.e. pH, density, viscosity

- Explosive Supplier
- Shotfirer
- Magazine Keeper

### Failure to conduct quality tests
- Incomplete documentation/practices

- Conduct PTO’s or audits quarterly to ensure compliance with procedures.
- All blast crew to be trained in the potential consequences of failing to ensure the characteristics of the product loaded.

- D&B Engineer

## Cause 2: Geological conditions

<table>
<thead>
<tr>
<th>Potential Cause</th>
<th>Likely Indicators</th>
<th>Possible Control Measures</th>
<th>Responsibilities</th>
</tr>
</thead>
</table>
| Lack of relief in weak/soft strata. Inadequate confinement. | Recording areas of weak/soft strata. Fume generation | Understand geology of each shot and design blast (timing and explosive product) to ensure adequate relief. | Mine Geologist
|                                  |                                          |                                                                  | D&B Engineer          |
## OPEN CUT OPERATIONS

### WHC_PRO_OC_BLAST FUME MANAGEMENT

<table>
<thead>
<tr>
<th>Potential Cause</th>
<th>Likely Indicators</th>
<th>Possible Control Measures</th>
<th>Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sympathetic detonation Flyrock</td>
<td>Minimise blast size and depth. Appropriate explosives product selection. Change design to suit conditions.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dynamic water in holes Preceded by the observation of slumped blast holes. Usually when using non water-resistant explosive products Loss of product whilst loading blast hole.</td>
<td>Minimise or eliminate sleep time of shot. Measure recharge rates if dewatering, and choose explosive products according to manufacturer’s recommendations. Record slumped holes and use this information to build understanding of pit hydrology. Selection of appropriate explosives product</td>
<td>Shotfirer D&amp;B Engineer Geologist</td>
<td></td>
</tr>
<tr>
<td>Explosive product seeping into cracks Slumping Not achieving collar height during loading Poor reconciliation between design and loaded explosives volumes</td>
<td>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.</td>
<td></td>
<td>Drill Operators Shotfirer D&amp;B Engineer</td>
</tr>
<tr>
<td>Moisture in clay Fume Incorrect explosive</td>
<td>Consider water resistant explosive products and how this may impact sleep time.</td>
<td></td>
<td>D&amp;B Engineer Geologist</td>
</tr>
<tr>
<td>Blast hole wall deterioration between drilling and loading e.g. cracks, voids, hole contraction Traceable to specific geological areas Poor drill and load reconciliation</td>
<td>Employing different drill techniques for soft ground Minimise time between drilling and loading. Use hole savers/water while drilling. Ensure benches are unaffected by back-break from earlier blasts e.g. pre-splits.</td>
<td></td>
<td>Drill Operators D&amp;B Engineer</td>
</tr>
</tbody>
</table>

**Cause 3: Blast Design**
<table>
<thead>
<tr>
<th>Condition</th>
<th>Fume</th>
<th>Appropriate separation of explosive decks. Initiation timing.</th>
<th>Responsible Person</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intra-hole explosive desensitisation in decked blast holes</td>
<td>Fume</td>
<td></td>
<td>D&amp;B Engineer Shotfirer</td>
</tr>
<tr>
<td></td>
<td>When using decks only, inconsistent blast performance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explosive desensitisation due to the blast hole depth</td>
<td>Fume</td>
<td>Reduce bench height. Ensure adequate relief in deep holes.</td>
<td>D&amp;B Engineer</td>
</tr>
<tr>
<td></td>
<td>Poor blast performance</td>
<td>Follow manufacturer's recommendations on explosive product selection and blast design for deep holes i.e. decking where appropriate.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Poor dig rates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inappropriate priming and/or placement</td>
<td>Residue product</td>
<td>Follow manufacturer's recommendations on explosive product initiation.</td>
<td>D&amp;B Engineer Shotfirer</td>
</tr>
<tr>
<td></td>
<td>Inconsistent blast</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>performance</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Misfire</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excessive confinement (Incorrect Timing and Pattern Design)</td>
<td>Fume</td>
<td>Understand geology of each shot and design blast (timing and explosive product) to ensure adequate relief in all strata. Consider incorporation of a free face, reduction of powder factor, modified timing, depth of blast.</td>
<td>D&amp;B Engineer</td>
</tr>
<tr>
<td></td>
<td>Specific to blasts known to be confined</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Poor dig rates</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>No free face present</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Excessive powder factor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desensitisation of explosive column from in-hole detonating cord initiation</td>
<td>Fume</td>
<td>Follow manufacturer's recommendations on compatibility of initiating systems with explosives.</td>
<td>D&amp;B Engineer Shotfirer</td>
</tr>
<tr>
<td></td>
<td>Inconsistent blast</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>performance</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Only in areas where in-hole cord initiation is used</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primer of insufficient strength to initiate explosive column</td>
<td>Poor blast performance</td>
<td>Follow manufacturer's recommendations on compatibility of initiating systems with explosives.</td>
<td>D&amp;B Engineer</td>
</tr>
<tr>
<td></td>
<td>All blasts using a particular primer type/ size</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Failure to identify potential causes of fume generation</td>
<td>Limited experience designers</td>
<td></td>
<td>D&amp;B Engineer</td>
</tr>
<tr>
<td></td>
<td>Training</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### WHC_PRO_OC_BLAST FUME MANAGEMENT

<table>
<thead>
<tr>
<th>Potential Cause</th>
<th>Likely Indicators</th>
<th>Possible Control Measures</th>
<th>Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inadequate analysis or records</td>
<td>Follow WHC_PRO_OC_BLAST PLANNING, DESIGN &amp; RECORD KEEPING.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excessive energy in weak/soft strata desensitising adjacent explosive product columns</td>
<td>Fume</td>
<td>Understand geology of each shot and design blast (timing and explosive product) to match, e.g. reduction of powder factor.</td>
<td>D&amp;B Engineer Geologist</td>
</tr>
<tr>
<td></td>
<td>In specific areas known to contain weak/soft strata</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Cause 4: Explosive Product Selection

<table>
<thead>
<tr>
<th>Potential Cause</th>
<th>Likely Indicators</th>
<th>Possible Control Measures</th>
<th>Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explosives product selected not suitable for the prevailing ground conditions (water, rock mass strength)</td>
<td>Fume</td>
<td>Follow manufacturer’s recommendations on explosive product application.</td>
<td>D&amp;B Engineer Shotfirer</td>
</tr>
<tr>
<td></td>
<td>Poor blast performance</td>
<td>Review of the site design records/ results for previous blasts in similar strata.</td>
<td></td>
</tr>
<tr>
<td>Non water-resistant explosive products loaded into wet or dewatered holes</td>
<td>Fume</td>
<td>Follow manufacturer’s recommendations on explosive product selection.</td>
<td>Shotfirer D&amp;B Engineer</td>
</tr>
<tr>
<td></td>
<td>Poor blast performance</td>
<td>Regular education of shot crew on explosive product recommendations from supplier.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Discipline in on-bench practices.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Weather forecasts to be obtained and considered.</td>
<td></td>
</tr>
</tbody>
</table>

#### Cause 5: On Bench Practices

<table>
<thead>
<tr>
<th>Potential Cause</th>
<th>Likely Indicators</th>
<th>Possible Control Measures</th>
<th>Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inter-hole explosive desensitisation</td>
<td>Fume</td>
<td>Reduce bench height or ensure adequate relief in deep holes.</td>
<td>Drill Operator D&amp;B Engineer Shotfirer</td>
</tr>
<tr>
<td></td>
<td>Blast holes drilled too close together.</td>
<td>Product selection.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Blast hole deviation</td>
<td>Initiation/timing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inconsistent blast performance</td>
<td>Increased control on deeper designs/ GPS drilling assist</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Review product selection, adjusting for actual drilling.</td>
<td></td>
</tr>
</tbody>
</table>
## OPEN CUT OPERATIONS

### WHC_PRO_OC_BLAST FUME MANAGEMENT

<table>
<thead>
<tr>
<th>Condition</th>
<th>Action</th>
<th>Responsible Party</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hole condition incorrectly identified</td>
<td>Slumping of holes Unexpected material in drill cuttings</td>
<td>Shotfirer</td>
</tr>
<tr>
<td></td>
<td>Dip all holes prior to loading. Record wet, dewatered and dry holes on blast plan and use this information as a basis for explosive product selection. Minimise time between drilling and loading, especially in soft and clay strata. Note: Enough time should be allowed for any dynamic water in the hole to be identified. Minimise sleep time. Training/competence of blast crew.</td>
<td>Shotfirer</td>
</tr>
<tr>
<td>Blast not drilled as per plan</td>
<td>Can be correlated with inaccurately drilled patterns</td>
<td>Drill Supervisor D&amp;B Engineer Shotfirer</td>
</tr>
<tr>
<td>Inadequate mixing of raw materials</td>
<td>Frequent NOx fume in all areas associated with loading from a specific delivery system Product appearance abnormal</td>
<td>Shotfirer MMU Operator</td>
</tr>
<tr>
<td>Poor bench preparation not allowing for water run-off.</td>
<td>Pooling of water Hole collars show effects of water damage</td>
<td>Drill Supervisor OCE</td>
</tr>
<tr>
<td>Dewatering of holes diverts water into holes previously loaded with dry hole explosive products</td>
<td>Only when using non water-resistant explosive products Fume generation</td>
<td>Adjust explosive product selection according to manufacturer's recommendations. Bench cleaned up for effective water run-off.</td>
</tr>
</tbody>
</table>

*"If it's not safe, don't do it."*
<table>
<thead>
<tr>
<th>Training/competence of blast crew.</th>
<th>Location of dry hole explosive products considered in dewatering discharge locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall on a sleeping shot.</td>
<td>Slumping of holes Poor blast performance</td>
</tr>
<tr>
<td>Review rainfall forecasts for planned sleep time of shot and select explosive products according to manufacturer's recommendations. Maximum sleep times will be followed according to the specifications details on the Technical Data Sheets (TDS) for each explosive product. Minimise sleep time for dry blast hole explosive products if rain is predicted. Bench cleaned up for water runoff. Seal top of blast holes to prevent water ingress e.g. with gas bags. Consider removing water affected product. Consider early firing of blast.</td>
<td></td>
</tr>
<tr>
<td>Shotfirer Drill Supervisor</td>
<td></td>
</tr>
<tr>
<td>Blast not loaded as per blast plan</td>
<td>Not achieving collar height during loading Poor reconciliation between design and loaded explosives volumes</td>
</tr>
<tr>
<td>Training/competence of blast crew. Effective supervision. Communication of loading requirements. Record actual loadings e.g. product, quantity, height.</td>
<td></td>
</tr>
<tr>
<td>Shotfirer D&amp;B Engineer</td>
<td></td>
</tr>
<tr>
<td>Blast hole deterioration between drilling and loading</td>
<td>Fume Inconsistent column rise while loading Poor drainage Traceable to specific geological areas</td>
</tr>
<tr>
<td>Minimise time between drilling and loading. Use hole savers. Optimise drilling practices to minimise hole damage through rock cracking etc. Where practicable design blast to minimise impact to next bench.</td>
<td></td>
</tr>
<tr>
<td>Drill Operator D&amp;B Engineer Shotfirer</td>
<td></td>
</tr>
</tbody>
</table>
### Cause 6: Contamination of explosive in the blast hole

<table>
<thead>
<tr>
<th>Potential Cause</th>
<th>Likely Indicators</th>
<th>Possible Control Measures</th>
<th>Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explosive product mixes with mud/ sediment at bottom of hole.</td>
<td>Water/mud identified in hole</td>
<td>Optimise drilling practices to minimise blast hole damage.</td>
<td>Drill Operator</td>
</tr>
<tr>
<td></td>
<td>Blasts containing wet/dewatered blast holes only</td>
<td>Ensure appropriate loading practices are followed during charging.</td>
<td>Shotfirer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ensure primer is positioned in undiluted explosive product.</td>
<td>MMU Operator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Insert gas bag to separate mud/sediment from explosive product.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use blast hole savers</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use end of loading hose dispersers to minimise contamination.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Decking to eliminate contact with known dynamic water.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Verify correct hose handling practices are in place.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use suitable, safe dewatering techniques.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Training/competence of blast crew.</td>
<td></td>
</tr>
<tr>
<td>Penetration of stemming material into top of explosive column (fluid/pumpable explosive products only)</td>
<td>Fume</td>
<td>Use appropriate stemming material.</td>
<td>Shotfirer</td>
</tr>
<tr>
<td></td>
<td>Increased stemming usage</td>
<td>Ensure explosive product is gassed to manufacture to specifications before stemming.</td>
<td>MMU Operator</td>
</tr>
<tr>
<td></td>
<td>Blasts charged with fluid/pumpable explosive products only</td>
<td>Seal top of explosives column prior to stemming e.g. gas bag.</td>
<td></td>
</tr>
<tr>
<td>Moisture in ground damaging explosive product</td>
<td>Wet ground occurrence</td>
<td>Explosives product selection.</td>
<td>Shotfirer</td>
</tr>
<tr>
<td></td>
<td>Fume generation</td>
<td>Use hole liners where product not water resistant.</td>
<td>MMU Operator</td>
</tr>
<tr>
<td></td>
<td>Consistent level of surrounding groundwater</td>
<td>Load wet holes first and dip remaining holes prior to loading.</td>
<td>D&amp;B Engineer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adjust explosive product selection according to manufacturer's/supplier's recommendations.</td>
<td></td>
</tr>
</tbody>
</table>
| Contamination of explosives column by drill cuttings during loading | Hole collars not consistent size  
Inside of hole collars show disturbance  
Column rise varied from design | Verify correct hose handling practices are in place e.g. operator competence, procedures, use explosives supplier’s personnel.  
Training/competence of blast crew.  
Minimise vehicle contact near blast holes.  
Use hole savers. | Drill Operator  
Shotfirer  
MMU Operator |

"If it's not safe, don't do it."

UNCONTROLLED COPY WHEN PRINTED.  
REFER TO INTRANET FOR LATEST VERSION
5.7. **FUME RATING SYSTEM**

<table>
<thead>
<tr>
<th>Level</th>
<th>Typical Appearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 0 No NOx gas</td>
<td></td>
</tr>
</tbody>
</table>
| Level 1 Slight NOx gas | [Image]
| 1A Localised | ![Image](image1.jpg)
| 1B Medium | ![Image](image2.jpg)
| 1C Extensive | ![Image](image3.jpg)
| Level 2 Minor yellow/orange gas | [Image]
| 2A Localised | ![Image](image4.jpg)
| 2B Medium | ![Image](image5.jpg)
| 2C Extensive | ![Image](image6.jpg)
| Level 3 Orange gas | [Image]
| 3A Localised | ![Image](image7.jpg)
| 3B Medium | ![Image](image8.jpg)
| 3C Extensive | ![Image](image9.jpg)
| Level 4 Orange/red gas | [Image]
| 4A Localised | ![Image](image10.jpg)
| 4B Medium | ![Image](image11.jpg)
| 4C Extensive | ![Image](image12.jpg)
| Level 5 Red/purple gas | [Image]
| 5A Localised | ![Image](image13.jpg)
| 5B Medium | ![Image](image14.jpg)
| 5C Extensive | ![Image](image15.jpg)

(Source: AEISG, 2011)

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 above. 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).

<table>
<thead>
<tr>
<th>Level</th>
<th>Colour</th>
<th>Pantone Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 0</td>
<td></td>
<td>Warm Grey 1C (RGB 244, 222, 217)</td>
</tr>
<tr>
<td>No NOx gas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level 1</td>
<td></td>
<td>Pantone 155C (RGB 244, 219, 170)</td>
</tr>
<tr>
<td>Slight NOx gas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level 2</td>
<td></td>
<td>Pantone 157C (RGB 237, 160, 79)</td>
</tr>
<tr>
<td>Minor yellow/orange gas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td></td>
<td>Pantone 158C (RGB 232, 117, 17)</td>
</tr>
<tr>
<td>Orange gas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level 4</td>
<td></td>
<td>Pantone 1525C (RGB 181, 84, 0)</td>
</tr>
<tr>
<td>Orange/red gas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level 5</td>
<td></td>
<td>Pantone 161C (RGB 99, 58, 17)</td>
</tr>
<tr>
<td>Red/purple gases</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5.8. SITE PLAN AND BLAST CLEARANCE EXAMPLE

<table>
<thead>
<tr>
<th>NAME</th>
<th>SIGNATURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
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<tr>
<td>3</td>
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<td>4</td>
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<td>5</td>
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<td>6</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

ROGGLEN COAL MINE
BLAST EXCLUSION ZONE
SHOT NO. 321
8TH MAY 2018
SITE CONTACT: 02 6740 7000
5.9. MEDICAL ADVICE

Advice to Medical Staff
in the Treatment of Those Who Have Been Exposed to NOx Gases.

The patient may have 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, N₂O₃, N₂O₄, N₂O₅). Nitrogen dioxide (NO₂) is the principle hazardous nitrous gas. 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 mechanism by which injury may occur. Inhalation results in both respiratory tract irritation and pulmonary oedema. High level exposure can cause methaemoglobinemia. 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 for up to 4-12 hours

MEDIUM TERM
• R.A.D.S. (Reactive Airways Dysfunction Syndrome
• In rare cases bronchiolitis obliterans which may take from 2-6 weeks to appear

LONG TERM
• Chronic respiratory insufficiency

High level exposure particularly associated with methaemoglobinemia can cause chest pain, cyanosis, and shortness of breath, tachypnea, and tachycardia. Deaths have been reported after exposure and are usually delayed. Even non irritant concentrations of NOx may cause pulmonary oedema. Symptoms of pulmonary oedema often don’t become manifest until a few hours after exposure and are aggravated by physical effort. Prior to 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 investigations are required:
• Spirometry
• Chest x-ray
• Methhaemoglobin estimation

Because of the risk of delayed onset pulmonary edema it is recommended that as a precaution the patient be observed for up to 12 hours. As no specific antidote for NOx exists, symptoms will have to be treated on their merits.
Toxicology of NOx (AEiSG, 2011)

Only one study (CSIRO Australia, 2007) has been found which attempts to quantify the size, concentration and longevity of post-blast gas plumes under realistic conditions pertaining to open cut mining.

However, the toxicology of NOx is well understood from controlled medical studies and this knowledge is embodied in exposure limits defined by organisations such as the US Environmental Protection Agency (EPA) and US National Institute for Occupational Safety and Health (NIOSH). The US EPA has compiled sets of Acute Exposure Guideline Levels (AEGLs) which represent threshold exposure limits for the general public and are applicable to emergency exposure periods ranging from 10 minutes to 8 hours.

The other relevant standards are known as IDLH Levels (Imminently Dangerous to Life and Health) which have been determined by NIOSH. These exposure limits are not considered relevant for public health scenarios, but are generally applied when selecting respirators in an industrial situation.

The toxicology of NOx is summarised below, but more information including detailed definitions of AEGL's and IDLH is contained in appendix 2.

Nitric Oxide (NO)
Under normal conditions, NO is actually formed at low levels in the body and it serves as an important regulator molecule for the human cardiovascular, immune and nervous systems. NO is even used therapeutically for the treatment of several conditions (for example: adult respiratory distress syndrome and frequent pulmonary hypertension in newborns). However, nitric oxide can be toxic in larger amounts because it combines with haemoglobin in the blood and prevents its normal oxygen-absorbing function. The toxicology of NO is complicated by the spontaneous formation of NO₂ which has its own adverse effects on the body. As a consequence, the toxicity of NOx is guided by the levels set for NO₂.

Nitrogen Dioxide (NO₂)
The first toxic effects observed with NO₂ exposure are related to irritation of the airways and eyes. These effects have been studied many times with human volunteers in control environments. Because NO₂ is not very soluble in the moist airways, some gas can reach deep into the lungs, causing delayed effects, notably pulmonary oedema (fluid on the Lung), which can cause death. Normally, asthmatics or people with chronic lung conditions (eg Bronchitis) are considered to be the individuals most 'at risk' in the general population. As with many toxic substances the observed effects depend on both the concentrations and the duration of exposure.

"If it's not safe, don't do it."
Table 1. Summary of toxic effects verses NO₂ Levels.

<table>
<thead>
<tr>
<th>NO₂(ppm)</th>
<th>Exposure period</th>
<th>Response in Healthy Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.04-5</td>
<td>Odour threshold</td>
<td></td>
</tr>
<tr>
<td>0.3-0.5</td>
<td>2 hr</td>
<td>Decreased lung function, cough and dry throat and mouth.</td>
</tr>
<tr>
<td>20</td>
<td>30 min</td>
<td>IDLH level (Immediately Dangerous to Life or Health)</td>
</tr>
<tr>
<td>30</td>
<td>40 min</td>
<td>Tickling sensation in nose and throat</td>
</tr>
<tr>
<td>30</td>
<td>70 min</td>
<td>Burning sensations and cough</td>
</tr>
<tr>
<td>30</td>
<td>2 hr</td>
<td>Deep chest burning sensations, short of breath</td>
</tr>
<tr>
<td>80</td>
<td>3-5 min</td>
<td>Chest tightness</td>
</tr>
<tr>
<td>90</td>
<td>40 min</td>
<td>Fluid in the lung</td>
</tr>
</tbody>
</table>

IDLH is defined by the US National Institute for Occupational Safety and Health (NIOSH) as the exposure that is "likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such and environment". The IDLH standard was developed to assist in selecting respirators in a work situation. It should be noted that delayed pulmonary oedema may not be accompanied by any other significant symptoms. This has been considered in the Acute Exposure Guideline Levels (AEGL). It is recommended to consult other authorities (medical) for further advice.

6. DEFINITIONS

Adverse Weather Includes rainfall, lightening, low continuous cloud, presence of upper class inversion, wind speeds greater than 7m/s.
Dewatered hole Wet hole removed of water with no water recharge
Dry hole Hole identified as being dry in the bottom and no wet or damp sides
Wet hole Hole identified as containing free water
Wet weather >20mm rainfall
7. REFERENCES

- AEISG Code of Practice – Prevention and Management of Blast Generated NOx Gases in Surface Blasting, 2011
- Australian Standard AS2187 Part 2-2006, Use of Explosives
- WHC-PLN-OC-EXPLOSIVE CONTOL PLAN
- WHC-PLN-OC-BLAST MANAGEMENT PLAN (Per Site)
- WHC-PRO-OC-LOADING and STEMMING BLAST HOLES
- WHC-PRO-OC-TYING UP SHOTS
- WHC-PRO-OC-WORKING IN A BLAST AREA
- WHC-PRO-OC-BLAST CLEARANCE AND FIRING
- WHC-PRO-OC-BLAST PLANNING AND RECORD KEEPING
- WHC-CHK-BLASTING
- WHC-CHK-SHOTFIRERS
- WHC-CHK-ENVIRONMENTAL BLAST HAZARD ANALYSIS

<table>
<thead>
<tr>
<th>Revisions</th>
<th>Revision Description</th>
<th>Who Consulted</th>
<th>Date</th>
</tr>
</thead>
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<tr>
<td>01</td>
<td>New document</td>
<td>Drill &amp; Blast Team</td>
<td>Feb 2014</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Environmental Team</td>
<td></td>
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<tr>
<td>02</td>
<td>Revision following DP&amp;E comments</td>
<td>Drill &amp; Blast Team</td>
<td>Feb 2015</td>
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<td>Environmental Team</td>
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<tr>
<td>03</td>
<td>Review Document</td>
<td>Drill &amp; Blast Team</td>
<td>May 2018</td>
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