Extractives industry
safe drill and blast in surface operations
code of practice

MinEx

Health and Safety in NZ extractives

Contents

Preamble

MinEx is the national Health and Safety council for New Zealand's extractive sector - the mining, tunneling and quarrying industry. Our principal purpose is to help the industry achieve its goal of being free from fatalities, injuries and diseases. MinEx is funded by the mining and quarry sectors – through the respective associations and a number of individual companies.

MinEx has identified the need to provide guidance on safe drilling and blasting practice in the extractives sector, to minimise risks for its members, its clients, their employees and the wider community.

The use of explosives to break rock involves the sudden application of large amounts of energy and is therefore a process requiring the effective management and control of activities to ensure that hazards are identified and appropriately controlled.

This Code has been developed to provide practical guidance regarding drilling and blasting activities that must be considered as part of the risk assessment process, and during the development of a health and safety management plan and associated operating procedures and work instructions. The Code is necessarily generic in order to remain applicable across a broad range of applications, in both surface and underground operations, using a variety of explosive products, to achieve different blasting outcomes.

It is understood that specific blasting practices and applications vary significantly across operations, and therefore, a review of these guidelines must be carried out for applicability on a site-by-site basis.

This Code should be read in conjunction with the Health and Safety at Work Act 2015; the HSWA (Mining and Quarrying) Regulations 2022 (the Regulations); AS 2187.2-2006 Explosives - Storage, Transport and Use Storage; and the Health and Safety at Opencast Mines, Alluvial Mines, and Quarries Good Practice Guidelines.

We acknowledge and thank the Australasian Explosives Industry Safety Group Inc. (AEISG) for their support and use of their Code of Practice – *On-bench Practices for open cut Mines and Quarries*. We also thank

representatives from OceanaGold, RedBull Powder Company, Orica, Blackhead Quarries, and WorkSafe for their contribution and support for this code of practice.

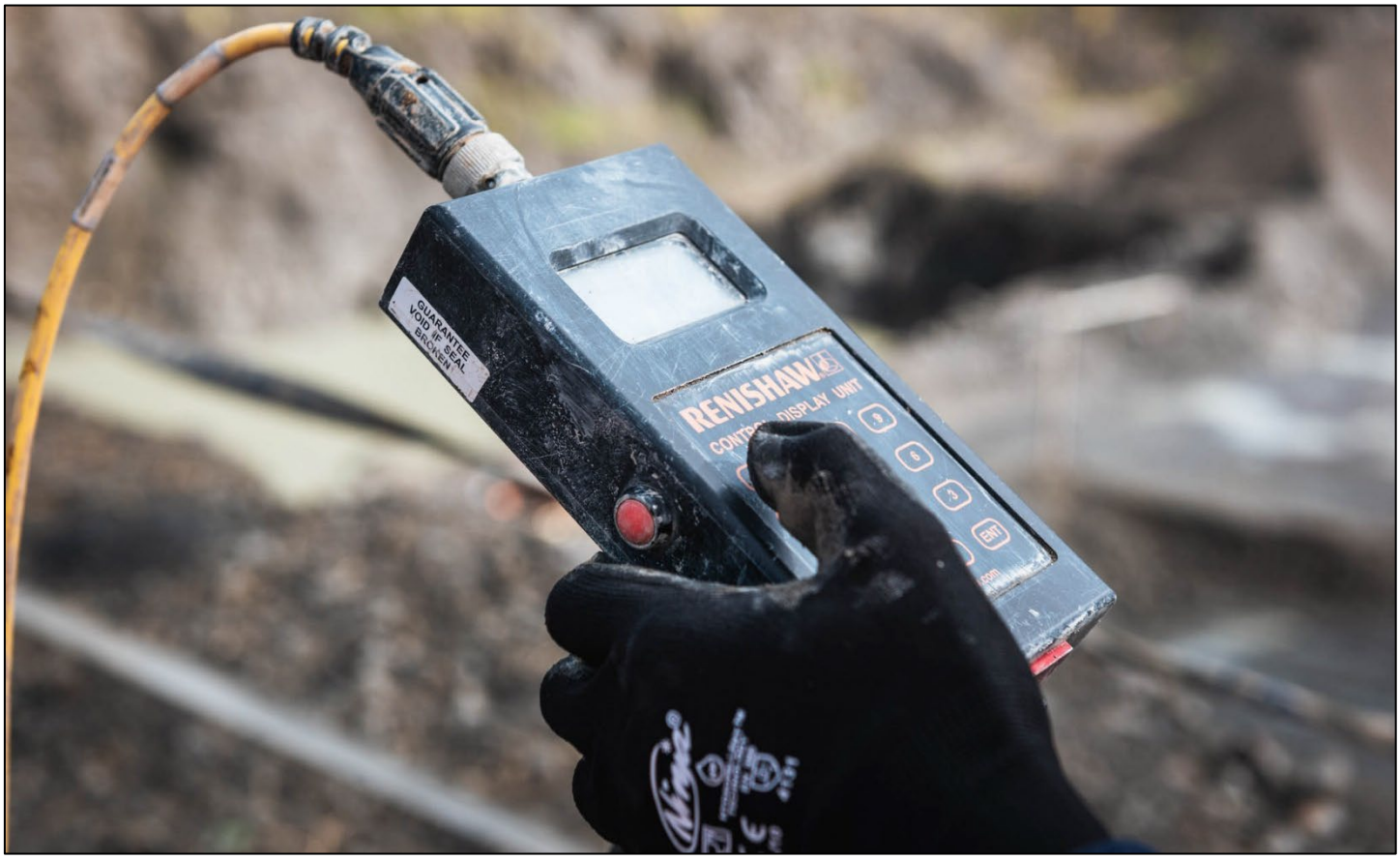
Scope

This code sets out recommendations and precautions to ensure the safety of employees, contractors, and members of the public, in relation to activities associated with drilling and blasting processes.

These guidelines apply to 'on-bench' and underground activities, including the preparation of a blast area, drilling of blastholes, the priming and charging of blastholes, stemming and the tie-up of charged blastholes ready for firing, firing of the shot, post-blast clearance and misfire management. The code also covers the requirements for the safe and secure storage and transport of explosives and security sensitive materials.

This code does not cover the management of hot and/or reactive ground, other than to the extent that general safe blasting practices must be observed for blasts. For further information on this topic refer to the AESIG Code of Practice on Elevated Temperature and Reactive Ground, which can be found at https://www.aeisg.org.au/aeisg-codes-of-practice/.

This code does not cover the management of post-blast fume, other than to the extent that the correct implementation of the blast design, appropriate explosives selection and water management, and good blast management will minimise the potential for post-blast fume. For further information on this topic refer to the AESIG Code of Practice on Prevention and Management of Blast Generated NOX Gases in Surface Blasting, which can be found at https://www.aeisg.org.au/aeisg-codes-of-practice/.



Definitions

AN – Ammonium nitrate.

ANE(s) – An ammonium nitrate emulsion, suspension or gel used as a precursor for the manufacture of explosives.

Associated works – Facilities such as magazines, process buildings and storages of energetic materials such as ammonium nitrate, emulsions/water-gels (ANEs) or other dangerous goods.

Bench – A ledge, which, in open-pit mines and quarries, forms a single level of operation above which mineral or waste materials are excavated from a continuous bank or bench face.

Bench height – The vertical distance between the base of one bench and the base of the overlying bench. The main constraint on height of bench is usually the limiting thickness that can be handled by the drills and/or the loading equipment.

Berm or safety bund – A small horizontal shelf which is usually the remnant of a bench left within the final pit wall slope. The primary purpose of a safety berm is to catch small rocks falling off the sides of the pit walls, to provide access for drainage, and for general slope stability.

Blast boards – Designated boards located in areas where general site personnel gather or pass, dedicated to the site blasting activities and indicating the location, time and date of any scheduled blasting on a mine/quarry site.

Blast area – The area where blastholes are to be charged and fired, and within which access will be restricted to authorised persons, authorised vehicles, or personnel/vehicles under the supervision of authorised persons. The blast area may also include clearance distances outside the immediate charging area. For example, drilling, excavation and other operations may be restricted, adjacent to, above or in front of the immediate charging area.

Blast Controller – A person who is appointed and responsible for the logistics of the clearance of the Blast Exclusion Zone, including the removal of personnel and equipment, the positioning of blast guards, and completion of a final sweep prior to firing. In some cases this will be the Shotfirer.

Declared danger zone (Reg 122 part 2) – Declared danger zone means the area that no person may enter while blasting operations are to take place, established in accordance with the principal hazard management plan for explosives. The area that is determined by a risk assessment process, to ensure that all the expected/foreseen effects of the blast, are maintained within a controlled area. People and equipment should be removed from the Blast Exclusion Zone prior to initiating the shot.

Blast guard – Industry terminology for a hard barrier consisting of a suitable person and equipment (visual indicators, suitable vehicle and communications equipment), strategically located to prevent access of unauthorised personnel and traffic into a designated Blast Exclusion Zone.

Dynamic water – The flow of water into or through the blasthole that is sufficient to interfere with the charging process or degrading the explosives column due to its flow. Water is commonly considered to be ‘dynamic’ if recharge occurs after dewatering.

High-wall – The unexcavated face of exposed overburden and coal in a surface mine or in a face or bank on the uphill side of a contour mine excavation.

Low-wall – In an opencut coal strip mine, the low-wall is the slope of the overburden (spoil) dump, usually directly opposite the high-wall, separated by the bench width.

MPU – Mobile Processing Unit (refer AEISG Code of Practice, "Mobile Processing Units" Notification of Blasting Activities-Health and Safety at Work (Hazardous Substances) Regulations 2017 Part 9 –9.28 (2)).

Post-blast fume – The plume of material generated after the initiation of ammonium nitrate-based explosives, which is sometimes a yellowish through to a red/brown NOx colour.

PPE (Personal Protective Equipment) – Items of clothing or devices worn to protect an individual from the actual or potential risks to health or safety arising from an activity or process.

Pre-blast meeting – A meeting sometimes conducted at the edge of the delineated shot, prior to the shot being fired. The meeting should include the Shotfirer, Blast Controller, nominated Blast Guards and other personnel relevant to the blast such as technical representatives and/or supervisors.

Pre-shift meeting – A meeting conducted on a site prior to, or at the beginning of, each shift where relevant information is communicated to operational personnel, such as road reports, mining activities, blasting activities, sleeping shots, new hazards, misfires, changes to procedures, etc. Quarry operators and blasting crew personnel should attend together.

Protected works – The two classes of protected works are as follows:

(a) Class A: Public street, road or thoroughfare, railway, navigable waterway, dock, wharf, pier or jetty, marketplace, public recreation and sports ground or other open place where the public is accustomed to assemble, open place of work in another occupancy, river-wall, seawall, reservoir, water main (above ground), radio or television transmitter, main electrical substation, private road which is a principal means of access to a church, chapel, college, school, hospital or factory.

(b) Class B: Dwelling house, public building, church, chapel, college, school, hospital, theatre, cinema or other building or structure where the public is accustomed to assembling, shop, factory, warehouse, store, building in which any person is employed in any trade or business, depot for the keeping of flammable or dangerous goods; major dam.

Principal hazard (Reg 65) – Any hazard arising at the operation that could create a risk of multiple fatalities in a single accident, or that could create a risk of multiple people being exposed to potentially fatal health risks.

Principal Hazard Management Plan[1] **(Reg 67)** – The general purposes of the principal hazard management plans are to:

(a) identifies the nature of all principal hazards at any mining operation, and

(b) set out the measures that will be used to ensure that all principal hazards are effectively managed.

[1] HSAW (Mining and Quarrying) Regulations Reg 66-70, 86.

Shotfirer – An appointed person who uses blasting explosives and is responsible for preparing, charging and firing explosives. A Shotfirer will be nominated for each particular blasting activity.

Sleeping shot – A blast area containing explosives that is not yet ready for firing (i.e., loading is incomplete) or has been delayed due to charging constraints or unsuitable conditions (e.g., weather conditions).

Sleep time – The time between explosives being loaded into a blasthole and their initiation.

Site – indicates mine or quarry site.

Unauthorised persons – Personnel not associated with blast charging and shotfiring activities, who are not permitted to enter the blast area without permission of the nominated Shotfirer and then only under appropriate supervision.

Unauthorised traffic – Personnel operating machinery/vehicles not associated with blast charging and shotfiring operations, which are not permitted to enter the blast area without permission of the nominated Shotfirer and then only under appropriate supervision.

Windrow – The berm of material on the edge of dumps for trucks to back to when dumping overburden or along the crest of the high-wall to prevent equipment from going over the crest.

Introduction

The use of explosives to break rock at a mine or quarry is a hazardous process. The blasting procedure must be managed to protect workers and the public from the adverse consequences of a blast.

Safe and efficient blasting requires all quarry and mine operators and supervisors to understand and follow correct procedures for handling and using explosives. Practices that lower the risk of premature or inadvertent explosions and prevent the mishandling of explosives are important in maintaining safety.

It is the responsibility of site management to ensure all workers handling or using explosives are competent or always supervised by a competent person. Competence should include current relevant qualifications and approved handler certification.

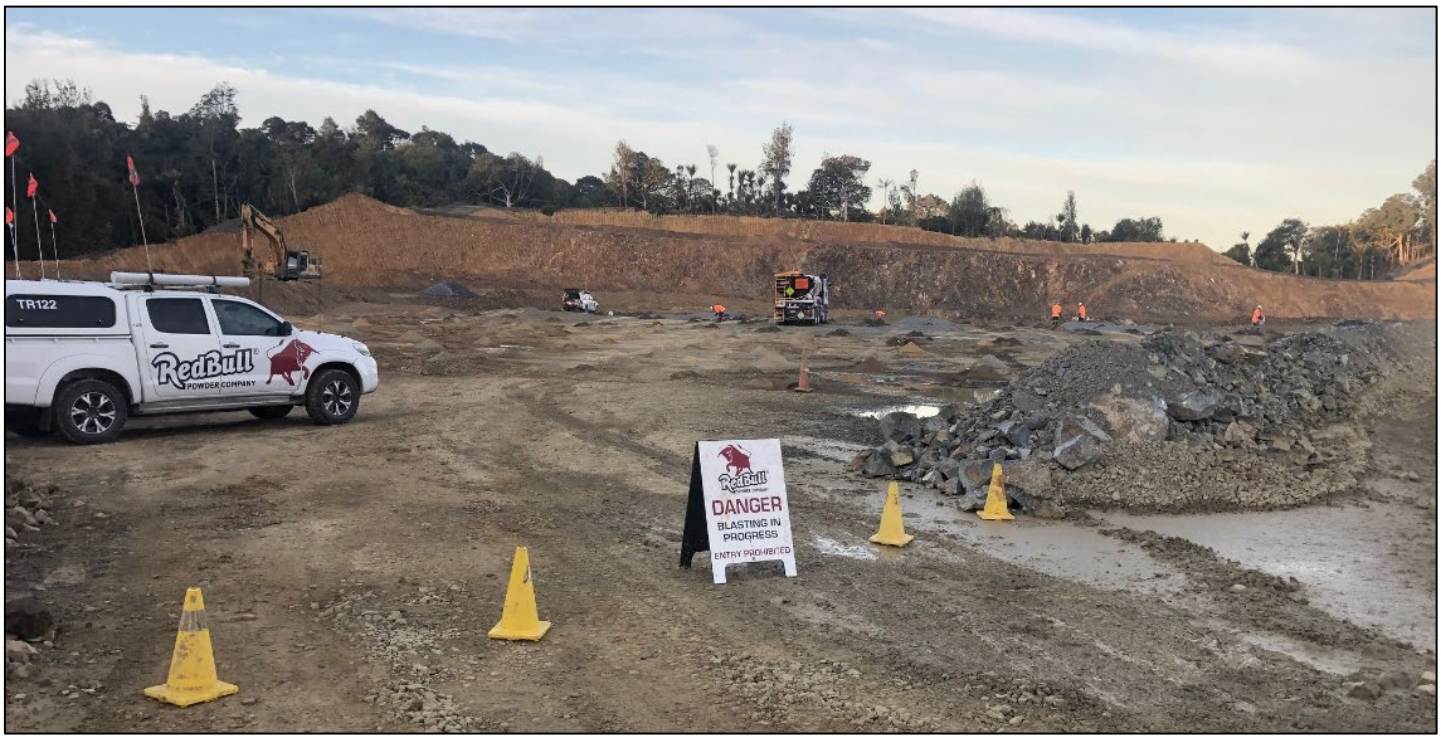
It is the responsibility of all persons involved in the blasting process to use risk management principles to assess hazards and implement necessary controls for activities or processes, where there is a risk of personal injury or equipment damage. It is also the responsibility
of all persons working on blasting activities to adhere to the relevant site-specific operating procedures.

Any use of explosives (or associated activities) is considered a principal hazard. Therefore, any operation where explosives are used must have an explosives Principal Hazard Management Plan (PHMP). Sites where explosives are used must have an appointed manager qualified in accordance with the Regulations[2].

This Code should be used when developing or reviewing management systems that relate to drilling, blasting and explosives.

[2] HSAW (Mining and Quarrying) Regulations Part 1, subpart 2

Risk Assessment



A risk assessment should be completed for each blast, identifying the hazards and controls at each stage, including the extent of the blast exclusion zone during the firing sequence. Any risk assessment and subsequent hazard controls should be agreed to and approved by all the relevant parties involved in the blasting process before blasting.

Factors to be considered during the risk assessment include (but are not limited to) the following:

a) The location of protected works and/or associated works, and any external infrastructure potentially affected by the drilling and/or blasting activities (air, road, rail, power, pipelines, underground workings etc.)

b) Planning and design – Identifying the hazards and controls associated with specific blast types and ground conditions, and the potential impacts on subsequent mining activities, wall stability, environmental impact, downstream processing etc.

c) Bench preparation and demarcation – Identifying the hazards and controls associated with equipment and personnel working within the blast area, including broken ground, cavities, vehicle rollover, unsafe high-walls/low-walls, adverse slope and crest conditions, unauthorised access, water management and interaction with other mining processes.

d) The type of shot and direction of firing, considering the mining/quarrying method, excavation equipment to be used, direction of fire and initiating point.

e) Known geological variation within the blast design area. This includes the presence of hard/soft bands or zones, faults, joints & bedding planes, dykes & sills etc.

f) Likely geotechnical conditions, including groundwater, the presence of voids (either natural or from underground workings), previously blasted broken ground, unstable crests and walls/slopes, or the potential for elevated temperature and/or reactive ground.

g) Access to/from the blast area, and within the blast area, and the ability to charge and sequence all blastholes to design specifications. This may include consideration of a Traffic Management Plan to

ensure that charging, dewatering and stemming equipment can access all blastholes safely, without the need to drive over blastholes or straddle charged holes. The Traffic Management Plan should include a designated park up area to minimise vehicle interaction. This minimises the risk of impact or damage to initiating systems from vehicle traffic and stemming operations, and the potential for misfires or unplanned detonation.

h) Access to and from the proposed declared danger zone. A declared danger zone should be identified prior to the commencement of charging and maintained at all times, in the event that evacuation is required due to approaching electrical storm, bushfire or some other emergency response. Mining processed adjacent to the blast area should not hinder this access.

i) Interaction with other mining processes adjacent to the blast area, such as drilling and excavation, and safety hazards associated with steep slopes, noise and dust.

j) Slip, trip, fall and manual handling hazards within the blast area, associated with uneven or muddy ground, or poor weather conditions.

k) The intended application and combination of specific bulk explosives, boosters, and initiating systems must be consistent with supplier guidelines. For example, suitability for use in elevated temperature conditions, or compatibility of initiating explosives such as detonating cord and boosters.

l) All drilling equipment, explosives, blasthole accessories, equipment and tools must be approved by management for use on site, with appropriate technical data sheets and safety data sheets provided by the supplier.

m) Specific risks associated with explosive products such as electric detonators and electrical/RF hazards; safety fuse and burning speed variability; and the potential for stretch-snap-slap shoot events when using signal tube systems.

n) Previous history of flyrock, poor fragmentation, inadequate/excessive blast movement, and/or excessive blast damage.

o) Previous history of excessive vibration, overpressure and dust, or complaints of disturbance from nearby community members.

p) The previous history of, and potential for, generation of post-blast fume (NOx) and associated blast size and sleep time restrictions, firing time limitations, or meteorological constraints.

q) The forecast weather conditions (particularly rainfall, lightning, dust storm, wind, and fog which may reduce visibility).

r) The location of equipment and personnel at the time of firing and any radio communication blackspots.

s) Daily planning/scheduling requirements and time available to complete necessary tasks.

t) Where required, blast design, measuring and monitoring devices (face profiling, blasthole bore tracking, temperature probes, gas monitoring systems, vibration/overpressure monitors, video equipment, etc.) should be available and calibrated.

u) Documented blast design parameters, including blasthole diameters, burden and spacing; bench height range; relative elevation of the bench; range of charge mass per hole or per deck; designed blast powder factor; timing, including the required inter-hole, inter-row, and downhole delays, and firing direction, and stemming parameters.

v) Additional controls and quality control records for any blasts deemed unusual or ‘high risk’. This may include secondary blasting considerations, firing multiple shots as a single event, or firing blasts near each other (measured horizontally or between different levels).

Once work in a blast area has commenced, all personnel must continually assess conditions and report hazards to the relevant supervisor of the work area. The site change management process must be well understood by all workers and work should not continue if it is not safe to do so.

All incidents and accidents must be reported to the site supervisor.

In some cases, additional risk assessments will be required for specific high-risk processes, such as blasting in elevated temperature and/or reactive ground areas, blasting in areas with a known history of generating post-blast fume, working in areas with cracked and/or unstable ground conditions, working under steep walls or slopes, or working in areas with noxious gases such as carbon monoxide and nitrogen oxides, either on the bench or during re-entry after the blast. Consideration should also be given to any old underground workings in the vicinity.

While the above risk assessment stages are not all directly associated with on-bench blasting activities, the various hazards and controls must be understood by personnel working on-bench to ensure that potential consequences are understood for the complete process.

Operational or specific risk assessments of on-bench activities are best carried out at the work area, prior to the commencement of work (e.g., SLAM, Take5, JSA, etc.). When a formal risk assessment is carried out it must be approved in accordance with the relevant safety management systems and accepted and signed by all of the relevant parties involved in that blasting process prior to work being undertaken.

Principal Hazard Management Plans (PHMP)

Any use of explosives (or associated activities) is considered a principal hazard under the Regulations[3]. Any operation where explosives are used must have an explosives PHMP and an Emergency Principal Control Plan (PCP) in relation to explosive emergencies.

Sites where explosives are used must have an appointed manager qualified in accordance with the Regulations[4]. A-grade quarrying operation where explosives are used requires a PHMP for explosives. (Refer Regulation 122).

Under Reg 66 (2) (b) of the Regulations, any mining operation where explosives are used must have a principal hazard management plan for explosives:

The Explosive PHMP must contain information detailed in regulations 68 and 86 of the Regulations. In summary, regulation 86 includes requirements for information on the following to be included:

- transporting explosives;
- explosive precursors;
- inspecting, reporting and undertaking actions to ensure safety of explosives and equipment;
- accounting for explosives;
- checking for deterioration of explosives;
- securing and storing of explosives;

[3] The Regulations, regulation 66 (2) (b)
[4] The Regulations, Part 1, subpart 2

- identifying and controlling hazards from charging and firing explosives;
- declaring danger zones;
- finding, recovering and detonating misfired explosives safely;
- keeping records of misfires;
- keeping a register of approved handlers;
- co-operating with explosives contractors or any other person authorised under the Health and Safety at Work (Hazardous Substances) Regulations 2017 regarding storage, handling, transportation and use of explosives.

Contractor Management

Contractors and sub-contractors play a major role in supplying drilling and blasting services to the mining and quarrying sector.

The site manager has responsibility for the health and safety of all workers who undertake tasks at the site – full time, part time and casual employees, contractors and their employees, sub-contractors and consultants.

Contractors, in turn must take reasonable care that their acts or omissions do not adversely affect the health and safety of other persons. Contractors and their employees must also comply, as far as they are reasonably able, with any reasonable instruction that is given by the site manager to allow the site to comply with relevant legislation and co-operate with any reasonable policy or procedure of the site relating to health or safety at the workplace.

Contractors and their employees need to be informed of all health and safety procedures, audits, investigations and the like so that they can assess the safety of their employees on site.

When engaging drilling and blasting contractors the site must:

a) Ensure that contractors are appropriately inducted to the site, covering all aspects of the work they are contracted to carry out.

b) Verify that contractors are familiar with the Blast Management Plant (PHMP for Blasting) for the site and that appropriate risk management practices and processes are in place.

c) Ensure that adequate supervision is provided for drilling and blasting activities at the site.

d) Ensure that the contractor has provided evidence of worker training and competencies for the drilling and blasting activities to be carried out at the site.

e) Verify that all plant and equipment brought to the site is fit for purpose and adequately maintained to ensure its safe operation whilst on site.

The templates in Appendix 3 include a sample Manager's Blast Checklist. Use of a checklist is recommended to prompt managers and supervisors on questions to ask, and hold points within the drilling and blasting process, at which the Manager or supervisor needs to ensure themselves that contractors are complying with all aspects of their safe work procedures and the site Blasting PHMP.

Blast Planning

Effective and safe implementation of the blasting process requires prior planning and scheduling on a daily, weekly, and monthly basis, to ensure that blasting activities can be carried out safely within required timeframes.

Face should be checked

Factors to be considered include:

a) The blast area is to be defined, designed and scheduled so that drilling, charging and firing requirements can be quantified and scheduled in advance;

b) The blast design and plan must consider the equipment to be used to ensure that all blastholes can be safely accessed and drilled to designed depths, angles and orientations;

c) The blast area must be available for blasting operations to proceed, without unsafe interaction from other mining/quarrying activities such as excavation and haulage. Consideration should be given to the effective use of physical barriers such as safety berms;

d) Bench preparation is to be completed on time, to an adequate standard for safe and efficient drilling and charging;

e) Drilling operations are to be progressed at a rate that will allow blasting operations to commence and be completed on time, without excessive sleep time as a result of drilling delays;

f) Interaction between drilling equipment and blast crews is best minimised to prevent unnecessary additional risk. If working near a drill is required it should be done under an appropriate risk assessment with consideration of all relevant issues, including, but not limited to:

- increased noise and dust levels;
- potential for fluid injection injury if there is a hydraulic line burst;
- clearance separation from the front deck of 2x drill rod lengths in case the drill rod dislodges from the carrousel;

- access to the drill rig for servicing and in an emergency; and
- a delineated exit path for the drill at the completion of drilling.

Minimum stand-off distances (for example re-drills), must be determined by a specific risk assessment;

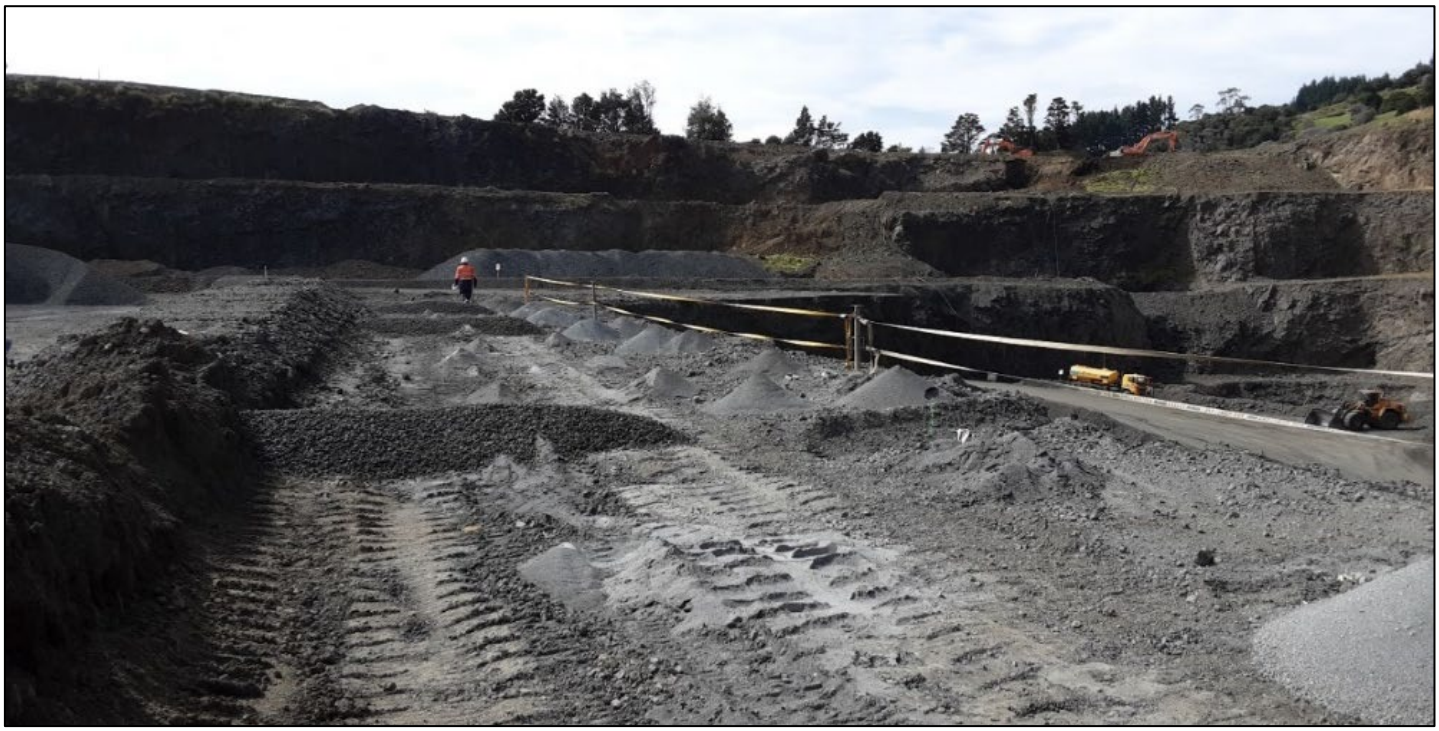
g) Sufficient explosives products and blasthole accessories are to be available (or have been ordered) to allow blasting operations to commence on time and be completed. In particular, bulk explosive blends to suit likely ground conditions (dry, damp, wet), a sufficient number of initiating products (of appropriate length and delay), gas bags (if required) to suit blasthole diameter, sufficient suitable stemming material etc.;

h) Sufficient labour and equipment are to be available to complete the blast in the required timeframe, without rushing and allowing time for unforeseen events, adequate checks and record keeping;

i) The shot must be completed and then fired within an acceptable timeframe (sleep time), allowing for explosives limitations, weather conditions/delays, weekends, and interaction with other processes. Limiting sleep time can be dependent upon ground conditions (elevated temperature, dynamic water etc.), or the sleep time parameters of either the bulk explosives (e.g., dry/damp/wet conditions) or the initiating explosives (e.g., diesel ingression into signal tube);

j) The sleeping of blasts outside normal operating hours must take into consideration requirements for maintaining restricted access and explosives security, with appropriate demarcation, guarding and supervision, to also be effective during any night shifts.

Bench preparation



Bench preparation is critical in establishing a safe working environment for all activities associated with surface blasting. Standards for bench preparation must meet the requirements of subsequent on-bench activity, in terms of the preparation and demarcation of those areas.

Factors to consider may include:

a) An inadequately prepared blast area can significantly impact the blasting process, with blastholes not correctly drilled or charged due to poor accessibility, and subsequent poor blasting outcomes including oversize, flyrock, fume, misfires etc.;

b) Bench preparation carried out prior to drilling may need to be repeated after drilling, particularly the clean-up between rows for access by personnel and equipment;

c) Inadequate demarcation and security measures can result in additional safety and security risks, particularly unplanned detonation risks associated with vehicle movements in the vicinity of initiating explosives, and the unexplained loss or theft of explosives;

d) Adequate bench preparation is required to suit all equipment operating on the blast bench, including drills, MPU's, stemming equipment, light vehicles, refueling vehicles, water carts, etc. This also applies where large bulk transport vehicles are delivering explosives precursors (AN, ANE) to reload areas;

e) Grades and cross-grades for access routes and the blast bench must be within the operating range for the most constrained (least flexible) equipment in use;

f) Adequate turn-around room, or drive-through access, for vehicle traffic on/through the blast area, such that vehicles do not need to tram over blastholes;

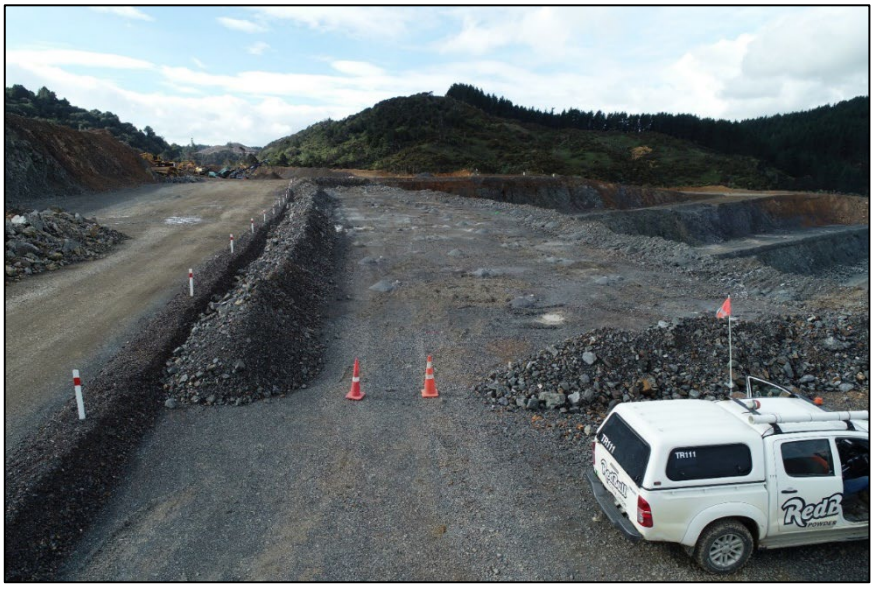
g) Appropriate clearances from high-wall and crest hazards is required for the safety of the blast crew. A minimum stand-off distance is required from all high-walls or low-walls. Most sites will use a minimum 10m stand-off dependent on the outcome of a risk assessment. The risk assessment should consider all relevant issues, including, but not limited to:

   - type of high-wall i.e., pre-split or buffer wall;
   - the angle/slope along the length of the wall;
   - size of the material on the face of the wall;
   - visible signs of material rolling off the wall or movement of the wall;
   - whether catch berms are in place at the toe of the wall and their condition;
   - whether catch benches are in place and their condition;
   - constant slope and angle of the wall; and
   - possible impact of changing weather conditions on the wall.

   The high-wall clearance zone should be delineated with a catchment berm to provide an identified barrier for the blast crew. If walls show evidence of movement, slabbing or section failure a detailed geotechnical review should be conducted. At sites where the blast crew are not in regular attendance or not familiar with the high-walls or low-walls (e.g., quarry sites with campaign loading) a risk assessment must be conducted, or half the height of the wall must be used as the stand-off distance. A crest berm or windrow should be constructed equivalent to half the height of the largest vehicle wheel working on the bench. If a continuous crest berm or windrow is not achievable, or if cracking or crest damage extends past the foot of the berm, the crest must be clearly demarcated by a paint line, flutter tape, cones or other identifiable means at least two metres from the crest edge;

h) The width and stability of narrow terraces within the blast area must be sufficient for all equipment likely to access those terraces;

i) Bench surfaces to be adequately prepared to provide a safe work area for the shot crew without unnecessary trip/fall hazards or climbing required. This must be done in a manner that does not push material into drilled blastholes;



Bench preparation with limited access

j) Bench surface to be prepared with consideration for natural drainage in the event of rainfall, to avoid accumulation of water on the shot and/or the creation of boggy ground conditions. Additional drainage may need to be established to remove accumulated water from the blast area, or prevent accumulation after charging has commenced;

k) Designated vehicle parking areas and tipping areas for stemming material. Access to the blast area is best restricted to essential vehicles, with non-essential vehicles parked safely outside the perimeter where possible. Stockpile areas for stemming material are also best maintained outside the blast area, with suitable access and stable ground for trucks to dump loads of stemming. Where stemming is dumped within the blast area, for manual stemming or placement by loading equipment, it should be placed prior to the commencement of priming and charging, with care to avoid driving over or covering drilled holes.

Following the bench preparation process, the bench standard should be formally accepted, in writing, by those conducting activities on the bench associated with blasting.

Declared danger zones

Physical exclusion zones and signage must be established to minimise the risk of inadvertent access to the blast area (or on-bench reload area) by unauthorised personnel/equipment, or access to unsafe crests or under unsafe wall conditions by personnel/equipment on the shot.

Declared danger zone demarcation can include a combination of physical barriers (safety berms), traffic cones, bunting, flashing lights etc. Signage should indicate an active blast area and must also indicate the status of that area (e.g., loaded shot, tied-up shot). This should include the area on the bench below the shot to prevent personnel and/or equipment moving too close to the face.

Drilling Blast Holes

The main risks associated with the drilling of blastholes are residual explosives from previous blasts being initiated and poorly drilled holes creating an unsafe situation during firing.

Blast geometry and design is imperative to create safe discharges and blast results.

Blasthole diameter, inclination and length should be adequately designed and recorded for the selected drill pattern. Correct drilling of blast designs will ensure safety hazards such as over break, fly rock or air blast overpressure are significantly reduced.

The following standards and procedures should be in place:

a) The drilling site should be prepared, and drill holes marked before drilling.

b) Drilling should not be carried out on any face or bench until it has been examined for misfires and suitably treated (refer to section on Treatment of Misfires).

c) The driller should record every drill hole including date, time, length, inclination, and position relative to a fixed point or benchmark.

Drill rigs working on a bench

d) The driller should record any unusual events during the drilling (e.g., cavities, soft rock, or an inability to drill designated holes).

e) When positioning the drill rig or while drilling near the edge of the bench, the drill rig should be positioned so the operator has a clear view of the edge at all times and far enough away to prevent the drill rig toppling

f) Drilling should not be carried out in a hole where any part is considered within an unacceptable distance from a hole containing explosives (minimum 2 burdens or spacings lengths).

g) If it is necessary to drill in or relatively close to an old hole or butt which is suspected of containing explosives, it should only be carried out after the hole has been flushed and a relief hole drilled at a safe distance.

Drill rigs are usually large, heavy and generally slow-moving units. They are complex machines, and their operation requires high levels of knowledge and skill. The safe use of a rig is heavily dependent on competent operators and a high standard of maintenance.

All rotating and moving components must be guarded to Australian/New Zealand standards. Ensure people working near rotating machinery do not wear loose clothing and do not have loose sweat cloths or cleaning rags on them.

Only authorised and competent operators should operate and move drill rigs. Never move a rig with the mast raised, except when moving between drilling positions on level, competent ground. Before moving a rig, make sure that you will not endanger other people by doing so and be aware of overhead hazards, especially powerlines.

Bulk Explosives Selection

The following considerations are relevant to explosives selection and delivery:

a) Bulk explosives must be charged under the supervision of the Shotfirer, to design charge mass and column rise as per design guidelines (charge sheets) and to suit the ground conditions encountered;

b) Blasthole conditions (rock type, depth, wet holes, wet/damp walled conditions, and likely sleep time) will determine bulk explosives selection. Blast designs must clearly indicate the conditions under which specific bulk explosives can (or cannot) be used. Suitable blasthole identification and records must be maintained to ensure correct charging;

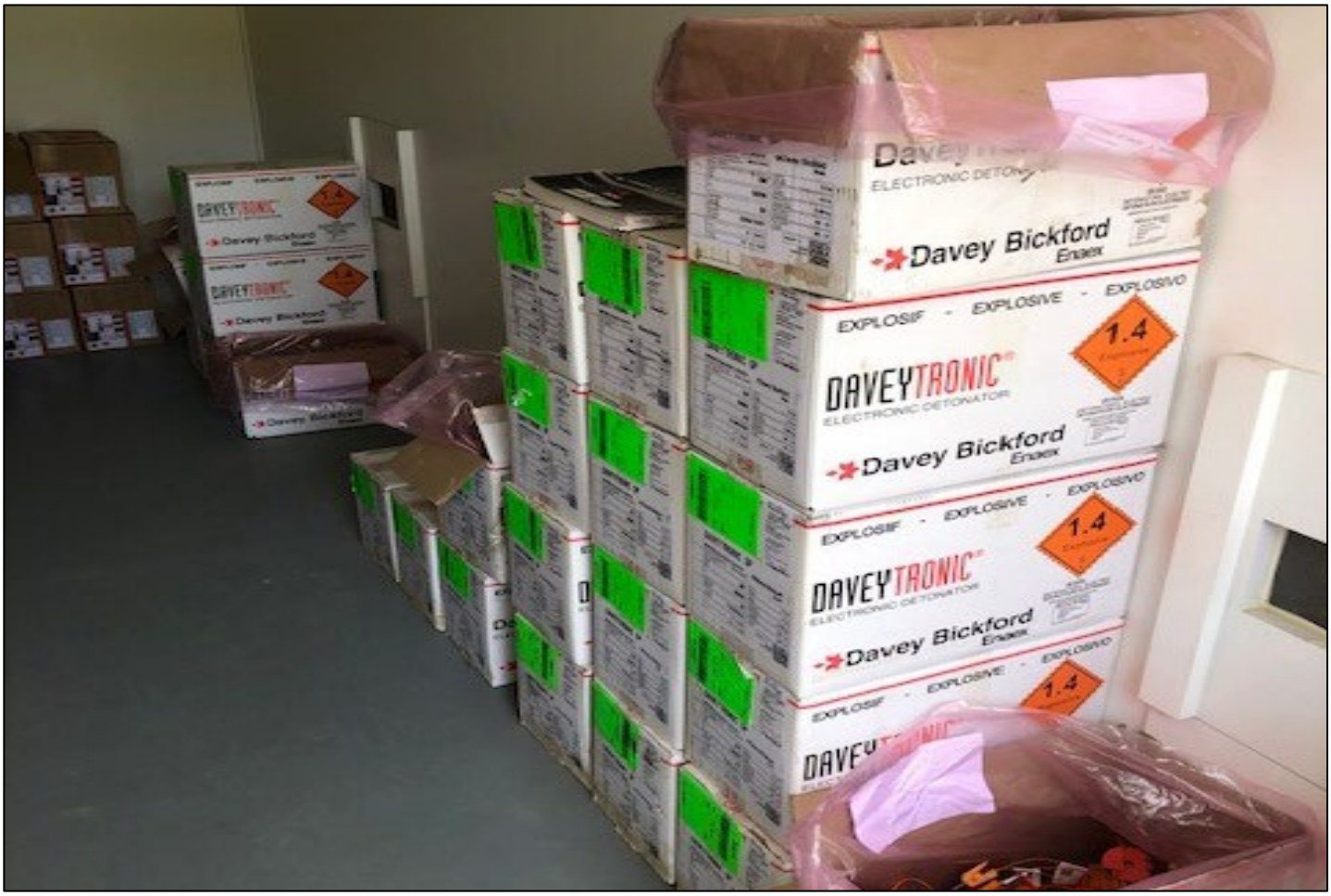
c) Bulk explosives must be selected with appropriate properties for the intended application, including water resistance, minimum diameter, critical density, and depth limitation, and suitable explosive performance for the ground type and pattern size being used;

d) Dry hole explosives (ANFO and heavy ANFO blends) can be augured into dry blastholes, or dry-sided blastholes where contact with water at the toe has been effectively sealed with a gas bag and drill cuttings;

e) Heavy ANFO blends that are suitable for damp-walled conditions can be augured into blastholes that have been dewatered, or where contact with water at the toe has been effectively sealed with a gas bag and drill cuttings, assuming that significant recharge is not taking place. These blends must not be augured into water as it will cause product deterioration at the toe around the primer. The presence of dynamic (flowing) water prevents effective dewatering and blastholes in these conditions are not suitable for augured explosives;

f) Pumped emulsion blends suitable for wet conditions can be pumped into blastholes containing water, as long as the hose is lowered to the bottom of the hole and retracted slowly during the pumping process in order to effectively displace water from the hole, rather than entrap it within the explosives column. These blends must not be pumped into a wet blasthole from the collar, as this will seriously degrade the product. The presence of dynamic (flowing) water requires a bulk explosive with good water resistance and ongoing monitoring to ensure that the column is not being washed away. Dynamic water can degrade a column of pumped emulsion, even if loaded correctly.

Storage of Explosives



The use and storage of explosives is regulated under the Health and Safety at Work (Hazardous Substances) Regulations 2017- 9.27. We also recommend that storage of explosives should also be carried out in accordance with AS 2187.1-1998 Explosives - Storage, Transport and Use. This standard covers the requirements for magazines, segregation and separation distances, and emergencies.

When you store explosives, in a single location, you will require a location compliance certificate if the quantity exceeds the thresholds specified in the Health and Safety at Work (Hazardous Substances) Regulations 2017 Part 9-Subpart 9.26 (2).

Separation distances

Explosives storage facilities are not permitted in residential areas.

The storage facilities must meet the separation distances requirements defined in HSWA (Hazardous Substances Regulations) 2017 Section 9.27.

Where there are two or more explosives magazines in the same compound that are not separated by the inter-magazine distances - (excluding minimum detonator to explosives distances), the aggregate explosives quantity must be used in determining the required separation distances. Refer to table in AS 2187 3.2.3.2.

The minimum separation distance required between an explosives magazine and a detonator magazine depends upon the number of detonators stored (*Table 1*).

Table 1 – Separation distances between storages of detonators and explosives

Number of detonators	Separation distance unmounded (metres)	Separation distance mounded (metres)
2000	10	3.0
5000	10	3.0
10000	10	3.5
20000	13	4.5
40000	16.5	8
50000	18	9
100000	23	12

Mounding requirements

Mounding of an above-ground magazine reduces risk to nearby protected works in the event of an incident at the magazine and protects the magazine itself from projectiles and debris if there is an explosion at a nearby explosives storage magazine.

In general, mounding should satisfy the following criteria:

- earth used for mounding should essentially be free of stones;
- length of the mound should exceed the length of the magazine by one metre at either end;
- the mound, if next to a magazine, should be a minimum 300 mm above the height of the explosives in the magazine.

Specific guidance for the mounding of magazines, such as the minimum dimensions for various mounds, is given in Appendix 1. of AS 2187.1.

Earthing and lightning protection for magazines

All explosives magazines must be effectively earthed and the resistance to ground must be less than 10 ohm. Dry earth is not a good conductor of electricity, therefore the resistance is to be measured while the soil has minimal moisture, such as during the hottest, driest season.

In some instances, it may be necessary to use a significant earthing structure (e.g. large brass rods, frames), rather than one or two earthing terminals. The earthing terminal or related earthing structure must be free from paint or other coatings that may reduce its ability to conduct and dissipate the electrical charge to earth.

Relocatable steel magazines should be earthed at diagonally opposite corners and require no further lightning protection unless placed in a vulnerable location, such as:

- elevated positions (e.g., hills, top of waste dumps);
- high risk areas known to be highly susceptible to lightning strikes.

Lightning finials should be fitted to magazines in vulnerable locations and for any permanent magazine.

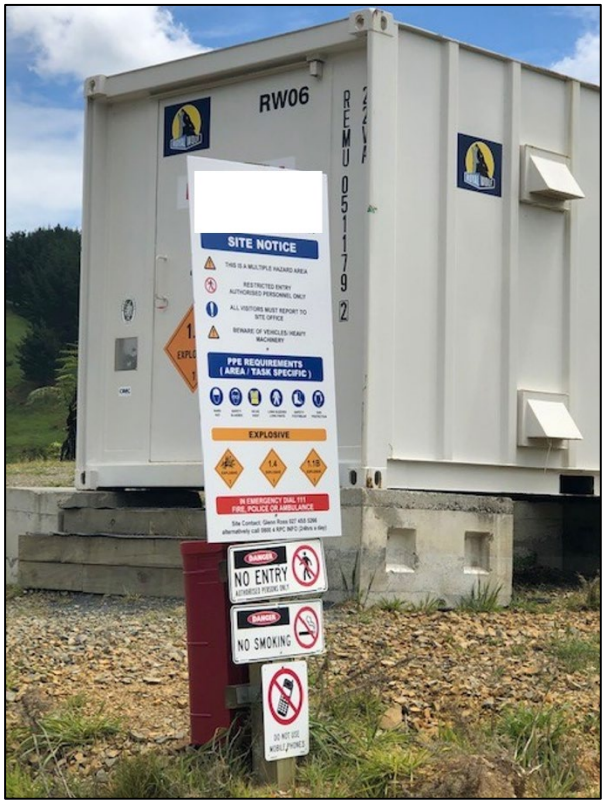
Security of explosives

Explosives must be kept in a locked magazine or receptacle of appropriate security and should be kept in a locked detached building not permanently occupied by people.

Incompatible explosives such as blasting explosives and detonators must be stored in separate receptacles or magazines. Depending on the quantity stored, magazines containing incompatible explosives must be spaced at least 10 m apart where unmounded. If the magazines will be located at a certain place for a long period (i.e., more than a year), it is recommended that there is an intervening mound between incompatible storages.

Adequate security needs to be provided for the explosives store. Only those people who are authorised for unsupervised access to the explosives (in accordance with the explosives PHMP) may have the means to unlock the explosives storage magazine. Explosives storages need to be locked at all times, other than when transferring product in or out of the receptacle, or when under constant supervision.

An inventory of explosives stored must be kept. A written record of all transfers of explosives in and out of the magazine must be recorded. Details recorded must include the date and time of the receipt or dispatch, name



Secure explosives storage

of person to whom an explosive has been supplied, type and quantity of explosive transferred and the balance of stock.

A stocktake must be taken every month to reconcile records. Any explosives found to be missing or stolen should be communicated to WorkSafe and/or NZ police as soon as reasonably practicable.

The explosives storage must be inspected monthly to determine compliance with the Health and Safety at Work (Hazardous Substances) Regulations 2017. A written record detailing the date and time of the inspection, the matters inspected and the findings of the inspection should be completed and retained.

Transporting of Explosives

Transporting on road

The person in charge of any transportation of explosives must ensure all requirements of the Health and Safety at Work (Hazardous Substances) Regulations 2017 are met as required. These include:

- Notifying the Commercial Vehicles Investigation Unit of the New Zealand Police at least 24 hours before departure on the first occasion of transport by a new route and at intervals no greater than 12 months.
- Making sure there is an approved handler controlling the transportation or the explosives are secured as required by the Regulations.
- Making sure vehicles meet the requirements of the Regulations, including placarding and documentation for Dangerous Goods transport.
- Making sure there are sufficient fire extinguishers of the right type.
- Only persons necessary for the transportation or emergency procedures are in the vehicle, but that a minimum of two people are present where quantities are greater than 250 kg.
- Making sure that the amount of explosives transported is within safe load limits.
- Making sure separation distances are maintained and drivers are informed verbally and in writing on the separation distances.

- Making sure vehicles do not stop except where there has been an accident, incident, emergency or need for urgent refuelling or as required by the Land Transport Act 1998. Where a vehicle does stop the duration must be minimised.
- The explosives must be managed according to the requirements for Level 3 emergency management planning as detailed in the Hazardous Substances (Emergency Management) Regulations 2007.

Transporting on bench

Good communication between all personnel within the blast area is required to ensure safe work and to ensure that vehicles do not drive over charged blastholes or initiating explosives. Consistent radio communication and/or hand signals must be understood by all personnel in accordance with the site's Traffic Management Plan.

Where necessary, a spotter shall be used to assist the operator of mobile equipment maneuver close to walls and crests, in close proximity to blastholes on tight patterns, when reversing or turning around on the bench, or in any situation where restricted visibility presents a risk.

All attempts should be made to prevent driving over blasthole collars, regardless of whether they are empty, primed or charged. If this is unavoidable then empty blastholes should be sealed with a gas bag to prevent backfilling, and primed holes must have their primers removed and be similarly sealed.

Under exceptional circumstances it may be necessary to traverse a charged blasthole. In this case, a risk assessment must first be conducted, and where deemed acceptable, visible downlines must be buried within the stemming zone and a spotter used to direct the vehicle such that it can safely straddle those blastholes and not drive over the collars.

Bulk explosives delivery records by truck and shift should be kept, that allow reconciliation of actual and design densities and quantities, of explosive products used, and identification of which holes were loaded by which truck. The manifests carried on any vehicles carrying initiating explosives should enable reconciliation of explosives stock.

On-bench Practices

The measuring and priming process requires the handling and management of sensitive initiating explosives and must be carried out by authorised and appointed personnel. This part of the blasting process must be conducted in a controlled, sequential manner to facilitate the tracking of explosives usage, and minimise the risk of damage/impact to initiating explosives from vehicles in the blast area.

To ensure safe and efficient on-bench activities associated with measuring and priming of blastholes the following should be considered:

a) Ensure that the blast area is suitable for charging activities, and that charging activities will not be compromised by other activities, such as bench preparation, drilling, excavation or vehicle movements in an adjacent area;

b) A clear blasthole identification system (such as row and blasthole number) must be in place to allow the correct treatment of all blastholes. This can be done by marking blasthole ID's on a peg or other marker at the collar;

c) Ensure that blastholes have been drilled to design (diameter, spacing, burden, location, depth, angle, and orientation) prior to charging, by reference to the blast documents showing the required layout

and any available drill logs. If this is unclear discuss with the supervisor, drill operator and/or engineer to clarify;

d) Variances in blast parameters require further assessment prior to charging, or remedial action such as re-drilling, backfilling or adjustments to the blast design such as charge quantity or initiation sequence. Acceptable variances must be communicated clearly to the Shotfirer, as such variances may be more critical in some cases (for example stem height variation when blasting near infrastructure, or explosives selection in fume-prone areas);

e) Where re-drills are required adjacent to (or within) the blast pattern, priming and charging of blastholes must be managed to prevent drilling in close proximity to explosives, with minimum acceptable drilling clearances from any charged blasthole. This must take into account the separation of angled and/or deviated holes at depth, and equipment capability. Re-drilling within, or adjacent to, a loaded shot and loading operations must take place under supervision of the Shotfirer, with clearly defined exclusion zones in accordance with applicable legislation and approved site practices. The relocation route of the drill and ancillary equipment (fuel and water trucks) through the blast area must be clearly defined and managed to avoid damage to other blastholes;

f) Clear blocked holes where possible to allow the placement of correct charge quantities. Where blastholes cannot be charged, or changes to priming requirements and/or charge quantities are identified outside the expected range for the blast area, this must be communicated to the supervisor for authorisation and recorded;

g) Where blastholes have been drilled too deep they are to be back-filled with suitable stemming material (or drill cuttings in dry conditions) to achieve the required depth;

h) Where blastholes have been redrilled, then previous ‘abandoned’ blastholes are to be identified and filled with suitable stemming material. Alternatively, ‘abandoned’ blastholes can be sealed with a gas bag and stemmed to prevent ejection when adjacent holes are fired. However, the creation of a cavity in close proximity to a charged blasthole should be assessed as it is likely to affect localised blast performance and may also result in additional fume;

i) When blastholes have been sealed at the collar with a gas bag then caution must be used when removing these devices to avoid ejection of material towards the operator’s face;

j) Where elevated temperature and/or reactive ground is expected or encountered, specific blasting procedures, explosives and controls will be required (see Explosives PHMP and site procedures);

k) Where blastholes are to be dewatered this must be carried out prior to the placement of any explosives in the blasthole, and in a sequence that avoids run-off into dry or previously dewatered blastholes and avoids the creation of boggy conditions for operating equipment. A sufficient delay between de-watering and charging the blasthole is necessary to determine if ‘dynamic’ water is present, as this will influence the product type loaded and the sleep time available.

Safe handling to avoid accidental initiation

When considering the potential for accidental initiation (such as when performing a risk assessment for digging a misfire) the potential for accidental initiation must always be considered. The cause of accidental initiation is always one or more of the following:

- Friction
- Impact
- Static
- Heat

The potential sources of F.I.S.H. must be considered in order to estimate possible risks when dealing with explosives.

Primary explosives are the most sensitive to F.I.S.H. and, depending on the actual explosive may detonate at very low levels of static. Lead Azide, the primary explosive in most detonators, will detonate from the static discharge from a person. In the field primary explosives are protected by the detonator can and the primer. All chemically sensitised explosives are sensitive to friction, impact, static, heat (FISH) and will readily detonate if abused.

Mechanically sensitised explosives require high levels of impact and shock to compress the gas bubbles fast enough to create hot spots.

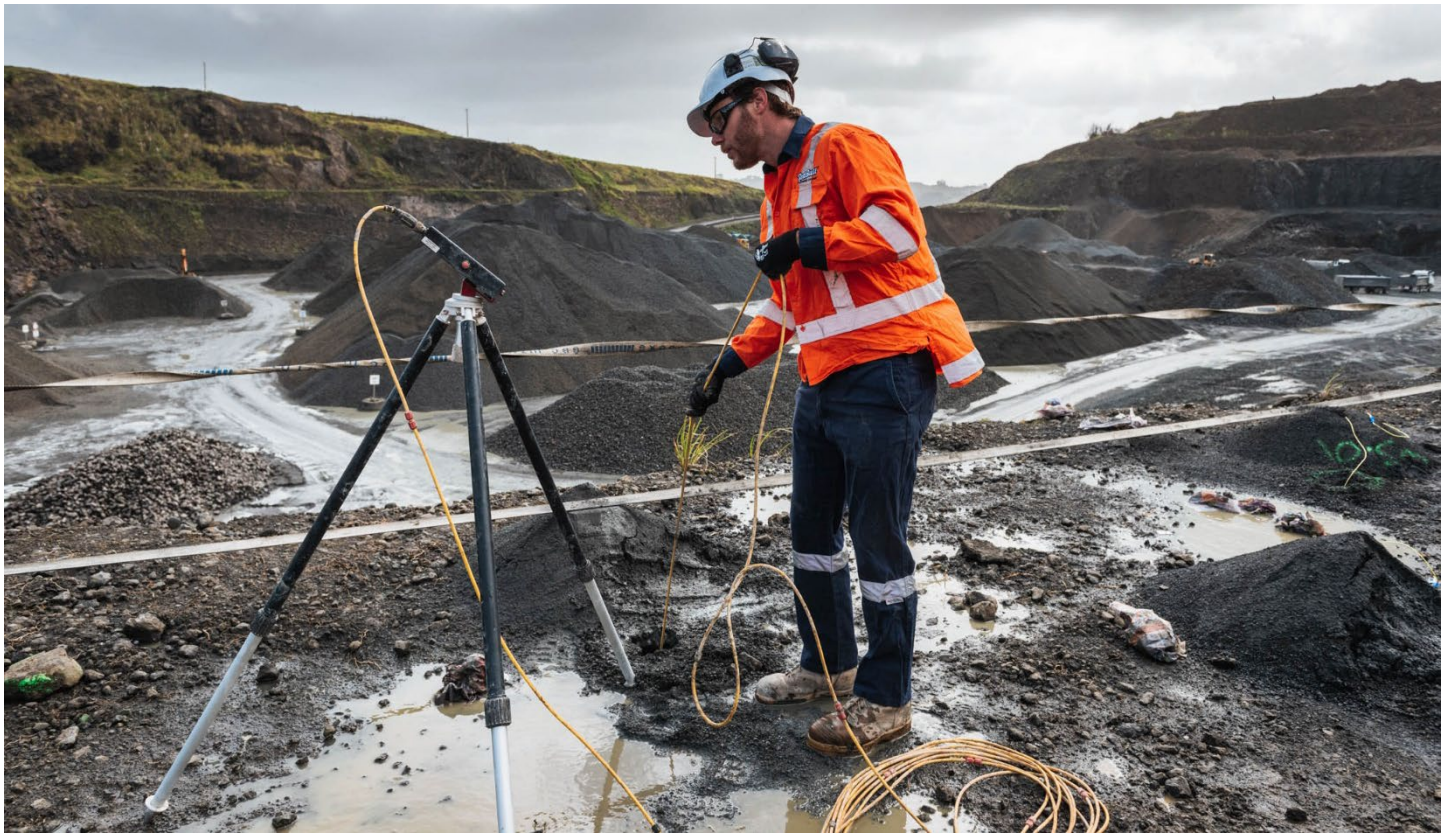
Authority to handle explosives

Any workers handling or using explosives must be competent (hold Certified Handler / CSL) or strictly always supervised by a certified handler. A certified handler is someone who has been certified to handle very hazardous substances. To obtain a Certified Handler Compliance Certificate, you will need to demonstrate the knowledge, experience and competence to safely handle the hazardous substances that your certificate will cover including:

- Hazardous properties of the substance and how to protect people. This includes the substance classification, regulations about safe handling, including safe work instruments, and what to do in an emergency.
- Working knowledge of any operating equipment, including the protective clothing and safety equipment required to handle the substance safely.
- The controls imposed by the Health and Safety at Work (Hazardous Substances) Regulations 2017.

Certified handler compliance certificates are issued by compliance certifiers and are valid for five years. The compliance certifier will tell you what they need from you before they can issue the compliance certificate.

Measuring blastholes



All blastholes must be measured prior to charging, in the event that re-drills or adjusted charging is required. If measurement was carried out prior to the day of charging, and a physical change to the blasthole is likely (e.g., following a rain event), then it is recommended that blastholes be re-measured prior to charging.

Blastholes are to be measured with a suitable (non-ferrous) weighted measuring tape or cord, of adequate length, to measure the deepest blastholes. Check that the tape has not been damaged and starts at the 'zero' mark. Depths are to be measured from the bottom of the blasthole to the collar at the bench surface, disregarding the height of the drill cuttings, and recorded on a blasthole-by-blasthole basis.

In addition to the depth of the blasthole, it is also advisable to record the depth of water in the hole and the extent of wet/damp sidewalls on the blasthole dipping sheet. Also note any evidence of collapse of the blasthole. This assists with appropriate bulk explosive selection and provides guidance in the event that post-blast fume is generated (**refer AESIG Code of Practice, "Prevention and Management of Blast generated NOX Gases in Surface Blasting**").

An assessment is to be made in the event of broken ground at the collar; reduced free-face burdens; excessive toe burdens; or reduced stand-off from broken ground, as to whether adjusted stem heights, primer locations and charge quantities are required.

Where the variation in front row burdens is critical, due to flyrock or overpressure risk, measurement of face geometry and blasthole deviation may be required with laser profiling and borehole tracking systems. Adjusted charge quantities, gravel decking and increased stem heights may then be required.

Where elevated temperature blasthole conditions are experienced or anticipated, temperature measurement will also be required (**refer AEISG Code of Practice, "Elevated Temperature and Reactive Ground"**). Specific explosives products and blast management protocols then apply.

Where specific strata or ground conditions needs to be identified (e.g., through-seam blasting, or blasting near underground workings), the use of geophysical logging equipment or borehole camera equipment may be required to identify the location of target horizons or structures. More accurate placement of explosive charges and aggregate decks will then be required.

Priming blastholes

Priming considerations should include the following:

a) Initiating explosives used in blasting need to be compatible with each other, with the bulk explosives used and with the environment in which the blasting is to be carried out. Further, they need to be used in accordance with the manufacturer's/supplier's recommendations;

b) A record of initiating explosives taken from the magazine, used, and returned to the magazine, must be maintained as required under the Site Security Plan. Boosters and detonators must be kept separate until assembled as primers immediately prior to placement in the blasthole;

c) The required number of boosters and downlines should be available for the shift, and laid out at the blasthole collars as required, with a peg (or other suitable retention device) to secure the downline at the collar;

d) Place initiating explosives on the same side of each blasthole in the row or echelon, on the opposite side from that being used by charging and stemming equipment (depending on traffic management guidelines for the blast area);

e) Carry out priming (and subsequent charging) in an identified sequence to facilitate the tracking of explosives usage, and minimise the risk of damage/impact to initiating explosives from vehicles in the blast area;

f) The use of initiating explosives retention devices at blasthole collars should be considered for the housekeeping of initiating explosives, as there is a potential for detonators and boosters to be misplaced within the drill cuttings or in soft/muddy ground or fall into the blasthole during or after placement. Further, such identification and retention minimises the potential for interaction with vehicles in the area;

g) Do not throw or mistreat initiating explosives. When making up primers, a detonator must not be forced into the booster. When cutting detonating cord, approved cutters must be used. Primers should be lowered carefully into the blasthole, not allowed to free fall to the bottom of the hole;

h) Primers are to be positioned as per decking guidelines (i.e., primed at the top, middle or bottom of the deck), subject to blasthole depth and blasthole condition. Primers are typically placed every 10 to 15 metres;

i) In dry (or damp sided) holes the bottom primer is normally positioned 1 to 2 metres off the bottom of the blasthole where it will sit within the bulk explosive when loaded;

j) If the bulk explosive will not easily flow past the top primer(s) positioned in small diameter dry holes, then these can be positioned during the loading process;

k) In water-filled blastholes the primer(s) is normally lowered to the bottom of the blasthole at the start of pumping and pulled up into the explosive column as it is charged. A member of the blast crew must monitor the primer when charging wet blastholes to ensure floating of the primer on top of the explosive column is prevented;

l) Additional primers may also be required in broken ground or areas likely to generate significant post-blast NOx fumes. Such primers should be timed to initiate simultaneously within the explosives column to eliminate the potential for column disruption, resulting in misfires;

m) Once primed, downlines must be secured at the blasthole collar, usually on the same side of the blasthole. Loose tails must be secured at the collar preferably on the side away from the charging vehicle, where they cannot be driven over or caught by passing traffic;

n) Primers should not be left unsupervised overnight in uncharged blastholes where they present a security risk. Where direct supervision cannot be satisfactorily addressed, primers must be removed from the blasthole, disassembled, and returned to the magazine;

o) Collect all waste packaging and dispose of according to site waste management practices. Check that such packaging is empty of all explosive products and 'Explosives' markings removed/covered prior to disposal;

p) The recording and reconciliation of initiating explosive quantities must be carried out against the quantities specified in the blast design, and the quantities issued from and returned to the magazine to identify correct usage and unexplained losses. Unexplained losses must be reported in accordance with site and regulatory requirements.

Charging and stemming blastholes

The charging and stemming process requires close attention to quality control, in terms of charge quantities, column rise, and stem height. Equally important is the need for safe on-bench traffic management, in terms of the interaction between equipment and personnel and the use of large equipment close to charged blastholes and initiating explosives.

Blast holes being charged

Blasthole loading is to be sequenced in such a manner that water displaced from wet holes does not run into previously loaded dry holes, or (where possible) create boggy conditions in areas still to be loaded. The treatment of blastholes as dry, damp or wet should also take into consideration the condition of surrounding blastholes, and whether significant rainfall runoff and water accumulation in low areas is anticipated.

When charging decked holes (particularly in pre-split or through-seam applications) additional care is required in terms of primer location, column rise, positioning of gas bags and stemming material.

The charging process is to be managed in a manner that allows the efficient and safe use of charging and stemming equipment, bearing in mind the interaction required between members of the shot crew working in close proximity to large mobile equipment.

Blastholes are to be charged systematically, in sections on large shots, allowing completion of a reduced blast area if unfavourable conditions (such as wet weather) are likely to prevent firing within the required timeframe.

Where blastholes cannot be safely charged or stemmed using explosives trucks or stemming vehicles, such holes may need to be charged and stemmed by hand.

Charging during hours of darkness requires additional controls and safety measures that include specific risk assessment, appropriate lighting, not working directly under or above any walls, reduced vehicle access into the blast area, and additional demarcation (e.g., flashing lights).

Charged quantities

During charging operations, consideration should be given to the following:

a) Check column rise during charging using a bobbing tape or dip stick, to ensure that blastholes are not over (or under) loaded outside acceptable tolerances for the blast. Delivered charge mass and measured deck length will usually be close to expected values, based on bulk explosive density and the nominal blasthole diameter, otherwise additional checks will need to be made;

b) Bulk explosive cup or bucket densities must be routinely checked for each load, particularly where chemical gassing is employed. Variances outside expected ranges may be indicative of incorrect blend ratio, or inadequate/excessive gassing, and may be related to AN/ANE quality or truck calibration problems. Unexpected bulk explosives variance must be recorded and reported to the Shotfirer;

c) Bulk explosive density and charge mass may need to be increased where excessive toe burdens are identified at the face, or adjacent to short holes, to achieve a higher powder factor. This should only be done following consultation with the Shotfirer;

d) Bulk explosive quantities may need to be reduced (or removed) from free-face blastholes with inadequate burden to contain explosive energy, or in areas of broken ground;

e) Where blastholes have been under-charged, additional top-up amounts may be acceptable within design charging and stem height guidelines. Stem heights should not be reduced to accommodate design charges;

f) Where blastholes have been overcharged, excess product may need to be removed. Following a satisfactory risk assessment, an approved scoop or vacuum equipment appropriate for the task may be used to remove bulk explosives and stemming in order to achieve correct column rise or height. Care must be taken to ensure metal parts are removed from hoses and to secure downlines. This process must be carried out under supervision of the Shotfirer. Alternatively, excess bulk explosives can be purged (displaced) from the blasthole using water pumped from the explosives truck or a water cart;

g) If bulk explosives appear to be running away in broken ground (e.g., a lack of column rise) charging must be halted and the situation assessed on a case-by-case basis. The subsequent behavior of that charge (when detonated) will be uncertain, with a potential for excessive flyrock, overpressure or

fume. The safest practice is to attempt to remove the primer (if possible) then stem and abandon the hole. Alternatively, charging should be halted, the Shotfirer contacted, and an appropriate process determined e.g., a risk assessment is carried out and an increased blast exclusion zone considered;

h) Care must be taken not to lose downlines in the blasthole during the charging and stemming process. Preferably, downlines are to be hand-held during charging/stemming or, if this is not possible, secured at the collar. If lost downlines cannot be retrieved then the blasthole must be reprimed prior to further charging; (with accounting for any additional explosives required);

i) If bulk explosives have slumped after charging and the downlines lost and unrecoverable, the blasthole will need to be re-primed with additional charging in an attempt to minimise the risk of misfires. Such holes represent additional misfire risk and must be recorded and checked after firing, with accounting for any additional explosives required;

j) The location of overloaded blastholes must be communicated to the Shotfirer while charging is still taking place in the blast area. If this cannot be rectified then increased blast clearance distances may need to be applied;

k) When using packaged explosives in small diameter and pre-split applications, follow supplier guidelines regarding priming practices, placement and securing at the collar. Additional care needs to be taken to ensure that packaged product is reliably positioned along the length of the blasthole, suitably primed and securely fastened to avoid loss down the hole;

l) Recording and reconciliation of the quantities of explosives (and raw materials) delivered according to the delivery docket, should be carried out against the quantities specified in the blast design, and those loaded on a hole-by-hole basis during charging. This provides a check against average density and the ratio of AN, ANE and diesel in blended explosives.

Stemming

Stemming is not to occur until the Shotfirer has confirmed the hole quality requirements such as: gassing; stem heights; communication of electronics, etc. Note: Precautions need to be taken to prevent interaction between the downlines and personnel/traffic.

Stemming should be placed to design depths with previous bulk explosive column height checked after charging. Stem heights should be recorded to a specified accuracy, consistent with a safe and environmentally acceptable blast design.

Stemming must not commence in blastholes containing gassed explosives until such explosives have had sufficient time to reach their design density, and a check has been made that design column rise has been achieved and meets the requirements of the shot design.

Appropriate stemming material (size, type and quality) must be used. If aggregate stemming is specified, but not available, an increased length of drill cuttings may be required (dry holes only) to achieve adequate confinement and must be authorised by the Shotfirer or relevant site representative.

During the placement of stemming, either by mechanical or manual methods, downlines need to be secured to prevent loss down the blasthole, and to ensure that they are not damaged. Stemming should be delivered at a rate that minimises the risk of bridging of the
stemming column. Ideally, a spotter should be available to assist and protect downlines during the stemming process.

Stem heights may need to be increased where broken ground is evident at the collar, or where reduced face burdens are identified for the blasthole profile. Aggregate decks may be required where reduced burdens are identified lower in the blasthole profile. Actual stem heights and aggregate deck lengths should be recorded.

In wet holes, additional time needs to be provided to enable stemming to seat effectively.

Downlines can be loosened after stemming to reduce the risk of stretching or snapping due to possible slumping. Blastholes that have slumped after stemming must be recorded and reported to the Shotfirer. These holes shall be monitored, have their downlines loosened where necessary and re-secured and the stemming topped up as appropriate.

Uncharged blastholes must be backfilled, to prevent excessive venting/cratering when adjacent blastholes are fired.

Surface tie-up

The sequencing of blastholes permits the controlled release of explosive energy in a manner that provides the required level of confinement and burden relief to achieve the desired fragmentation and blast movement, while minimising the risk of undesired outcomes such as flyrock, overpressure, vibration, noise, misfires and poor fragmentation.

Careful consideration should be given to the following:

a) All non-essential vehicles must be removed from the blast area (or from the immediate vicinity of blastholes being connected), prior to the placement and connection of surface delays under the supervision of the Shotfirer. Tying up should not commence in an area through which vehicle traffic is still required;

b) The required number of surface delays (of the correct delay and length) should be available for the blast and laid out at the blasthole collars as required. Surface delays should be placed on the same side of each blasthole in line with the row to assist in their visibility. Initiating explosives must not be thrown or otherwise mistreated;

c) Slumped holes must be topped up with stemming or drill cuttings immediately prior to tie-up where possible and recorded;

d) Recording and reconciliation of the quantities of surface delays are to be carried out against the quantities specified in the blast design, and the quantities issued from and returned to the magazine, in order to identify correct usage and unexplained losses.

The lead-in-line can be placed at the initiation hole but must not be connected until the blast exclusion zone has been cleared and secured to prevent inadvertent access.

Signal tube systems

When employing signal tube detonator initiating systems the following factors should be considered:

a) Blastholes must be sequenced with the initiation point, inter-hole delays, inter-row delays and firing direction shown on the tie-up plan. Where additional or missing blastholes occur, alternative timing options or dummy delays can be employed to maintain the timing between rows and echelons as closely as possible;

b) Blastholes are to be connected along rows or echelons, leaving the control 'row' until all other holes have been connected;

c) Blastholes should be tied up as indicated on the tie-up plan (or instructions) provided in the blast documentation;

d) Ensure that surface connections are made in a logical sequential manner, to avoid missed holes, and used according to the manufacturer's recommendations;

e) While connecting surface delays at the collar, check downlines for damage (e.g., cuts) that could result in misfire. Place surface clips at the collar to facilitate checking, unless such units require burial;

f) The design capacity of surface connectors/clips is not to be exceeded, and outgoing tubes should be parallel (not crossed), with the jaws of the clip closed to retain them;

g) Ensure that surface lines are on, not pulled too tight, and have sufficient slack and tails to allow some freedom to move during firing as burden movement begins;

h) Once all holes have been connected, the shot must be visually inspected to ensure all connections have been made correctly, with suitably experienced members of the shot crew checking each other's work;

i) When tie-up has been checked, the blast area must be cleared of personnel and equipment, and unused initiating explosives returned to the magazine and properly reconciled;

j) Appropriate security and safety controls such as barriers, demarcation, signage and supervision must remain in place to prevent unauthorised or inadvertent access to the blast area, until effective blast clearance has taken place ready for firing. Once surface connection has been completed, a nominated member of the blast crew must stay in attendance until the Shotfirer returns to connect the lead-in line;

k) Where weather conditions prevent the firing of a tied-up shot during the shift, the shot will be untied in the first instance, however, if that shot is to remain tied up overnight additional controls will be required. These include disconnection of the control row, and any holes beneath a wall; supervision of the tied-up shot unless site security is deemed adequate without this; additional signage (e.g., shot tied-up) and demarcation such as flashing lights. Shots must not, however, be tied up during hours of darkness, or if it is not planned to fire the shot until the following day.

Electronic systems

When employing electronic detonator initiating systems, the following factors are relevant:

a) There is a number of electronic detonator systems available for initiation. These should not be intermixed and should only be used in accordance with the relevant manufacturer's/supplier's directions;

b) A tie-up plan, with firing times for each hole and deck of explosive and if required a programming/logging path, must be available prior to connection. This may have been generated using a computer programme compatible with the electronic system being utilised, or using some other system;

c) Electronic detonators should be logged in accordance with the manufacturer's/supplier's recommendations;

d) Once programming/logging is complete, test for leakage, missing detonators, and unprogrammed detonators, and rectify where possible;

e) Do not use a Blasting Control Box (with sufficient voltage and communication safety protocols to fire a blast) to test the detonators at the shot; these units are only to be used at the firing location after the blast exclusion zone has been cleared;

f) Prior to connection, test firing line continuity (if using a wired blasting control box) or radio communication (if using a remote blasting box) to ensure any issues can be rectified prior to firing time;

g) Once the blast exclusion zone has been cleared, and the site radio procedures followed, the security system can be enabled and firing procedure for the shot can commence. If necessary, document all error messages during the firing procedure and rectify where possible;

h) If the electronic system allows the blast to continue after notifying of potential errors, it is the Shotfirer's responsibility to assess the situation before allowing the blast to continue with known issues;

i) Adhere to the specific minimum re-entry times required by each system (depending on voltage bleeding rate) before the post-blast inspection or if the blast is aborted due to an error that requires re-entry. Typical minimum re-entry time is 5 minutes post-firing as long as there is no fume or fire visible;

j) Never connect electronic detonators to energy sources other than those designed to be used with the specific systems;

k) Never connect conventional electric detonators to electronic detonator circuits or electronic detonator control equipment;

l) Never connect electronic detonators from different suppliers to the same circuit or different suppliers' electronic detonator control equipment;

m) Never use an electronic system unless trained in its use and passed as competent by the supplier. Always use approved electronic system devices and hardware for each system;

n) Ensure the security system which allows firing of the electronic system is secure;

o) When lightning is suspected to have hit the general blast area, re-test all detonators for leakage and damage and remove any damaged detonators from the control line – do not attempt to fire downlines showing heavy leakage or damage.

Blast clearance, blast guarding and firing the shot

Blast notification, clearance and shotfiring procedures must be carried out in accordance with the site blast management system. A number of factors associated with blasting work will, however, require additional consideration when determining clearance distances, guard locations and shotfiring position. These must be communicated to, and agreed with the Blast Controller and include the following:

a) Are there any over-loaded or under-burdened holes that could not be rectified?

b) Were any potential misfire risks identified during charging, that have not been rectified?

c) Does the presence of broken ground increase the risk of flyrock, overpressure or fume, from otherwise apparently well contained areas?

d) Is the blast in an area with a known history of generating post-blast fume? Has the shot been sleeping longer than usual? Has slumping of blastholes taken place during loading? This may indicate an increased potential for NOx generation and subsequent transmission outside the blast danger zone, or mine site;

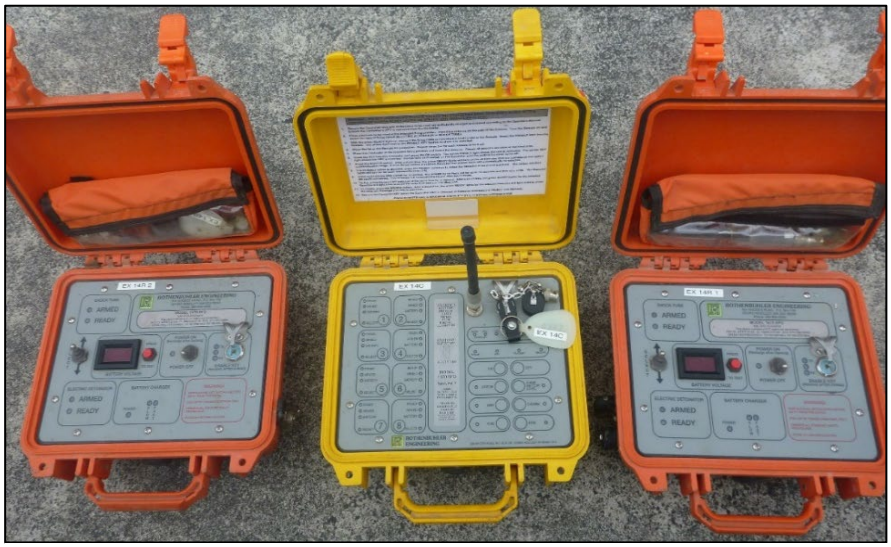
e) Is the blast in a hot/reactive area? Can the shot be fired in the necessarily short 'load and shoot' time that may be required?

f) Are there any ground stability issues that will require further assessment after the blast has been fired and delay re-entry?

g) Are multiple shots in the vicinity of each other being fired by one or more Shotfirers in the same firing window? Ensure clearance zones reflect the multiple shots, ensure all blasting devices are secured if re-entry to a particular shot is required, and consider the impact one shot may have on another with respect to the initiating systems used, and the sequence in which they will be fired.

Any and all variations to the blast, or measures undertaken to limit risks of potential hazards during blasting, should be agreed, recorded and signed off by the Blast Controller or relevant mine representative.

Post-blast assessment and reporting



Remote firing devices

Post-blast risk assessment takes place AFTER the shot has been fired. It is essential in order for safe work to resume in the vicinity of the blast and elsewhere within the Blast Exclusion Zone.

It is not uncommon for a shot crew to return to an adjacent area after firing, in order to commence work on the next blast. Alternatively, mining personnel may return to an area after firing, in order to commence excavation. You need to consider the following prior to commencing work:

a) The Shotfirer has confirmed that all explosives have detonated, that no misfires are evident, and that the shot has fired satisfactorily;

b) Any unsafe wall or crest conditions, or blast damage to the adjacent blast area, has been identified and either made safe or barricaded to prevent access;

c) Blast performance outcomes (fragmentation, movement, blast damage, environmental impact etc.) have been reviewed, and confirmation provided that subsequent blast designs remain appropriate. If not, blast packs may require update with respect to blasthole layout, charging, stemming and tie-up;

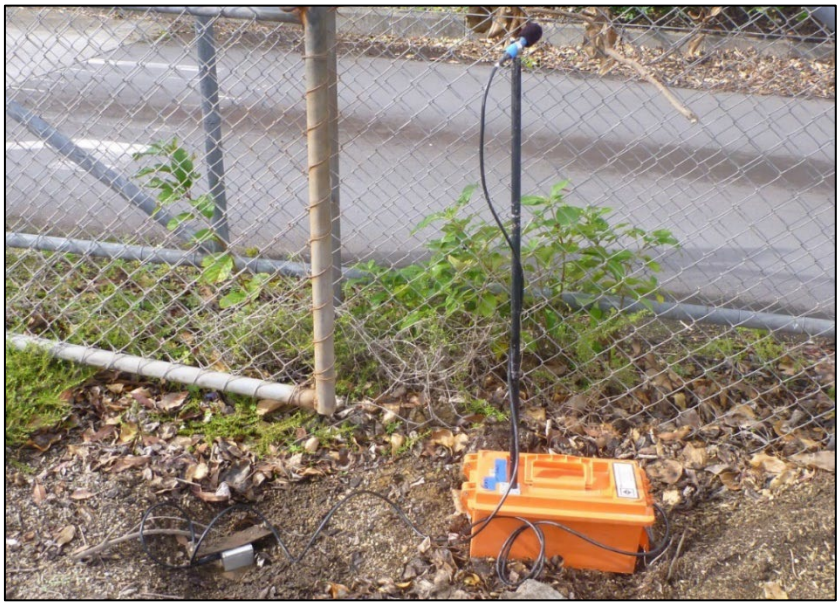
d) No site personnel, including the blast crew, can return to an adjacent loading area until the 'all clear' has been given, this will include sufficient time for dust and/or fume dispersal;

e) Access to, and effective demarcation around, the new blast area has been established, with windrows along new blasted boundaries;

f) Drilling requirements in the join-up area and in any previously drilled areas have been established, before further charging commences;

g) A documented blast hand-over process is observed, such that any relevant misfires or blast related hazards are communicated by the Shotfirer to the relevant Supervisor, and effectively communicated/demarcated for other personnel until rectified;

h) All relevant documentation associated with blasting activities needs to be completed in accordance with site and/or company procedures wherever relevant.



Blast monitoring

Treatment of misfires

All sites must have a written procedure that provides a safe system of entry and inspection for misfires and their treatment including the methods used for detecting a misfire.

Misfires must be reported to WorkSafe as a notifiable event under Regulations 225. Shot-firing notifiable incidents include:

- any incident in which any part of an explosive charge, after initiation, fails to completely detonate (misfires);
- any unplanned or premature ignition of a shot;
- any accident where a person suffers injury or dies as a result of shot-firing;
- any accident where material is projected beyond the declared danger zone; or otherwise exposes any person to danger during blasting operations.

Mining operations must address the procedure to find, recover, and detonate misfired explosives, as well as records to be kept of misfired explosives. The approved handler must ensure any misfired charge is identified and reported.

Methods used to determine if a misfire has occurred are based on many factors, including appropriate training, standard operating procedures, and guidance from standards[5]. There are certain events that indicate a misfire has occurred including:

a) If using safety fuse, the number of shots counted is less than the number of holes fired or a disagreement on the count of shots fired;

b) If damaged safety fuse, detonating cord, lead wires or unfired signal tube is exposed in a hole that has been fired;

c) Evidence of cut-offs, butts or remaining portions of holes (e.g., boulders with drill holes) that are suspected of containing explosives;

d) Holes that have slumped between charging and firing due to dispersion of the explosive from water ingress or through joints and fissures;

e) If during the normal excavation of the blasted ground, uninitiated or residual explosives are found or the load out mobile plant encounters poor 'diggability' of the blasted ground.

A careful examination of the debris for explosives must be undertaken which if present should be safely disposed of.

Having located a misfire, do not attempt to drill into the charged hole. A hazard identification and risk assessment should be undertaken to determine the safe treatment method.

A misfire among a number of charges may cause excessive rock scatter when fired because the successful shots have relieved the overburden. Adequate extra cover should be used in such cases.

Where a hole has completely misfired, the stemming may be removed by either applying water under pressure or by compressed air and water through a length of antistatic hose (i.e., FRAS). No metal fitting should be within the hole. Where water under pressure (or water and air pressure) is not available the stemming may be 'sludged' out using water and a wooden or other approved implement. Compressed air alone should not be used.

[5] AS 2787.2-2006 Explosives - Storage andUse

When the stemming has been removed a fresh priming cartridge may be inserted and the hole again stemmed and fired. An artificial burden or cover should be placed around and over the hole to prevent fly rock.

If a misfire contains ANFO or slurry or any other explosive rapidly destroyed by water, such explosive may be 'sludged' out down to the primer using the procedure described for removal of stemming above. The slurry explosive washed out should be treated as deteriorated explosives and appropriately disposed of.

The hole should then be re-primed and fired to explode the original primer. Do not remove a primed charge from the blasthole.

Where it is not possible to explode a misfire by re-firing, a relieving hole should be drilled parallel to the original hole then charged and exploded as follows:

a) Mark the misfired hole clearly or block it by inserting a wooden plug;

b) When the misfired hole is 50 mm or less in diameter and less than 3 m in length, do not drill the relieving hole closer than 600 mm to the nearest point of the misfired hole;

c) When the misfired hole is larger or longer than 50 mm and 3 m respectively, increase the distance between the misfired hole and the relieving hole so the misfired charge will not be drilled into;

d) When an electric detonator is involved, first short-circuit the detonator wires and then tie to some permanent object to recover the detonator after a relieving hole has been fired.

If the ground around the misfire has been shattered the relieving hole method should not be used. In this case the ground around the misfire should be carefully cleared until the explosives are uncovered. Do this cautiously by following the wires or fuses down to the charge, removing the last few inches of cover by hand.

No hole should be drilled in any face or bench until it has been thoroughly cleaned and washed down within a radius of 1m from the intended hole. Any cut-offs or sub-drill holes should be examined to make sure they do not contain explosives. Sub-drill holes should then be plugged with a wooden plug. If examination reveals explosives, the cut-offs or sub-drill holes should be primed and fired, and the pre-drilling precautions above taken again.

Where a misfired charge is identified the approved handler must ensure no-one approaches for 10 minutes in the case of an electrically fired charge. For a charge fired by a fuse this is 60 minutes. The certified handler must then safely depose of the malfunctioning charge in accordance with the Health and Safety at Work (Hazardous Substances) Regulations 2017.

General

Emergency response

Any operation where explosives are used must have an explosives Emergency Principal Control Plan in relation to explosive emergencies. The Emergency Management Control Plan must contain information detailed in regulation 105 of the Regulations[6].

Emergency scenarios relevant to on-bench activities include those that could lead to the unplanned detonation of explosives, such as lightning strike, fire on an explosives vehicle, heating caused by elevated temperatures or reactive ground, and those that could result in significant misfire risks such as major wall

[6] HSWA (Mining Operations and Quarrying Operations) Regulations 2016

failure above a blast area or flooding. These scenarios are managed according to site emergency response procedures.

In the event of an emergency situation that could lead to unplanned detonation, all personnel working within the designated **declared danger zones** must be evacuated. Blast guards must be posted to the relevant positions to ensure that the effects of any potential unplanned initiation are minimised.

In the case of lightning, established response procedures should define how to identify the point at which an approaching thunderstorm is considered a risk; the communication and clearance protocols necessary to evacuate and secure the emergency declared danger zones; and re-entry procedures. Storm warning systems should be utilised so that sufficient time is available to empty MPU hoses and augers, evacuate equipment and personnel, and secure safe exclusion zones around the blast area and explosives vehicle park-up area.

In the case of a fire on an MPU or an explosives transport vehicle an attempt to extinguish must only be made if the fire has been witnessed to have just started, if it is safe to do so (i.e. not directly associated with an AN, ANE or explosives storage area), and the person has been appropriately trained. In such cases, an emergency is to be called on the radio, the vehicle fuel isolated and the fire managed with on-board extinguishers. Otherwise, the area shall be immediately evacuated and an emergency exclusion zone established, with no other vehicles are to enter the area. The fire will be managed by the fire response team and re-entry prevented until the fire has burned out and the area has been cleared. Note: Special consideration should be given to the potential for fire at a bench re-load area where significant quantities of AN and ANE may be held on the surface. In such cases, exclusion zones may need to be increased.

In the case of expected flooding or wall failure, where immediate evacuation is not deemed necessary, restricted access may apply while the partially completed blast is prepared for firing to remove an otherwise significant misfire risk at a later time.

In emergency response scenarios, personnel may be directed to close the roadways and access paths to the designated Blast Exclusion Zone for the duration of the emergency event at the discretion of the site management team.

In accordance with site emergency procedures and/or the explosives company emergency procedures, the declared danger zones may be altered from the original plan, with due consideration given to the risk potential of the situation. In this event the parameters of the Blast Exclusion Zone will be communicated to all personnel in accordance with site procedures.

Appendix 1: Separation distances

The following table summarises the separation distances (metres) for the storage of explosives as given in AS 2187.1:1998.

NEQ stored (kg)	Protected Works- Class A	Protected Works – Class B Unmounded	Protected Works – Class B Mounded	Vulnerable facilities	Other storage Unmounded	Other storage Mounded	To process building Unmounded	To process building Mounded	To AN storage Unmounted
50	25	180	30	180	18	9	18	30	7
100	25	180	38	210	23	12	23	38	9
200	35	180	52	260	29	15	29	47	11
300	45	180	68	300	33	17	33	54	13
400	55	180	82	330	36	18	36	59	14
500	63	180	95	360	39	20	39	64	15
1000	100	180	150	450	48	24	53	80	18
1500	135	200	200	510	55	28	66	92	22
2000	160	240	240	560	61	31	78	105	23
2500	185	280	280	610	66	33	90	110	25
3000	205	305	305	650	70	35	105	120	26
4000	235	350	350	710	77	39	130	130	29
5000	255	380	380	760	83	42	140	140	31
7500	295	435	435	870	94	47	155	155	35
10000	320	480	480	960	105	52	175	175	39
15000	370	550	550	1100	122	61	200	200	45
20000	405	610	610	1220	135	66	220	220	49
25000	435	650	650	1300	145	71	235	235	53
30000	460	690	690	1380	150	75	250	250	56
40000	510	760	760	1520	165	83	275	275	62
50000	550	820	820	1640	180	89	295	295	67
75000	625	940	940	1880	205	103	340	340	77
100000	690	1040	1040	2080	225	115	375	375	84
120000	730	1100	1100	2200	240	120	395	395	89
140000	770	1160	1160	2320	250	125	420	420	94
160000	810	1220	1220	2440	265	135	435	435	98
180000	840	1260	1260	2520	275	140	455	455	105
200000	870	1300	1300	2600	285	145	470	470	110
250000	940	1400	1400	2800	305	155	510	510	115

NEQ = net explosive quantity, i.e., net quantity of explosive in the article or substance, excluding other constituents.

Appendix 2: Audit checklist to AS 2187.2

Blast site

Requirement	AS 2187.2	Findings
Area is demarcated and clearly identified from other activities on site.	s6.1.5	
A non-work zone established around the blast site for non-blasting related activities.	s6.1.5	
Restricted access to the blast site is enforced.	s7.2	
Face and/or high-wall are stable, and areas of potential risk identified and controlled.	s6.1.4	
Sufficient lighting provided when activities are undertaken at night.	s6.1.1	

Pre-charging activities

Requirement	AS 2187.2	Findings
Blastholes are checked for depth, blockages, water etc. and non-conforming holes are identified.	s6.1.7	
Appropriate risk mitigation process are undertaken to manage non-conforming blastholes.	s6.1.7	
Blasthole temperature readings are routinely undertaken in areas of hot or reactive ground.	s12.6.1	
Monitoring equipment, where required (vibration, overpressure and fume detection) is located in appropriate locations.	Good practice	

Explosives selection

Requirement	AS 2187.2	Findings
Explosives used are within manufacturer's shelf life.	Hazardous Substances Regs	
Explosives used are appropriate for the required undertaking.	s4.11	

Traffic Management

Requirement	AS 2187.2	Findings
Traffic instructions, when required, posted.	s5.2.2	
Blast site is made safe for the operations of explosives vehicle i.e., ramps not too steep, sufficient turning provisions etc.	s5.2.2	
Vehicle spotters are available and used when circumstances required.	Good Practice	

Charging activities

Requirement	AS 2187.2	Findings
All explosives are kept secure until ready for use.	s6.3.3	
Explosives are handled in a safe manner and in accordance with operating procedures.	Site HSMS	
Explosives that have been laid out for use are kept away from likely contact with vehicles and in a way that likelihood of being lost down a hole is minimised.	s6.5.1	
Primers and detonators are not made ready for use until needed.	s6.3.3	
Appropriate level of supervision is in place throughout the activity.	Good Practice	
Primers are lowered and placed in blastholes in accordance with procedures. **Note:** Be aware of persons allowing primer assemblies to free fall down the blasthole and failure to place primer in charged column as per procedures.	s7.4.4	
Blastholes are loaded as per activity procedure.	Good Practice	

Note: Most loading with hose requires that the hose is lowered down the hole and withdrawn up the hole as the column is being loaded. Lazy hose operators will just place the hose at the top of the hole.		
Detonator down-lines are secured in a way that minimises likelihood of being lost in blasthole.	s6.5.1	
Charge height is measured, and necessary remedial action taken if not to requirement.	Good Practice	
Column rise is measured, and necessary action taken if not to requirement.	Good Practice	
Housekeeping is undertaken as required including the placement of surplus detonators and primers into secure explosives vehicle.	Good Practice	
Due care is undertaken during stemming to prevent loss of detonator down-line and with downline being cut off with equipment such as stemming loader. **Note:** There have been several high potential incidents where lack of care by person operating stemming loader has resulted in primers being run over and crushed, downlines cut off or caught on equipment and stretched to breaking.	Good Practice	

Tie-in of shot

Requirement	AS 2187.2	Findings
Connections between down-line detonators to surface delay detonators (where applicable) undertaken in accordance with procedures. **Note:** Some surface delay detonator connectors require to be clipped in with tails facing in specific direction, or connections to be done in a specific manner.	Good Practice	
Connections between down-line detonators and surface communication cables (where applicable) undertaken as per procedures.	Good Practice	
Appropriate checks are undertaken to ensure all lines have been connected and connected correctly. **Note:** It is suspected that many of the occurrences of misfires are that thorough checks, to ensure that all connections have been undertaken, have not occurred. It is generally accepted that the nominated Shotfirer should walk the shot and part of his checks are to ensure, as far as reasonably practicable, that the tie in is complete and correct.	Good Practice	

Pre-shot initiation activities

Requirement	AS 2187.2	Findings
Any initiation equipment checks that are required for the initiation of the shot are undertaken.	Site HSMS	
Environmental conditions (wind cloud cover etc) are accessed as suitable for the activity to proceed or not.	s6.1.4	
Blast exclusion zones established and maintained. **Note:** There may be separate exclusion zones for flyrock and blast fumes.	s8.3	
All necessary area evacuations are undertaken, and evacuation areas checked to ensure all persons have evacuated.	s8.3	
All required communication notifications undertaken.	s8.3	
Blast guards briefed and posted to their nominated control points.	s8.3	
Communication between person initiating the shot and blast guards established.	s8.3	
All stakeholders in the activity agree that it is safe to proceed with the initiation of the shot.	s8.3	
Safe place for the person initiating the shot is identified.	s8.3	
Final warning signals (sirens or other) understood.	s8.3	

Post-blast activities

Requirement	AS 2187.2	Findings
All blast guards remain in place and prevent entry into exclusion zone until 'all clear' has been given. **Note:** Post-blast fumes may not always be immediately evident after the initiation of the shot. These may take minutes to be visible.	s9.1.2	
Shotfirer undertakes checks of blast (once dust and fume has dissipated and it is safe to do so) to ensure the site is safe for entry and that any identifiable misfires (if any) are noted and managed.	s9.1.2	
Post blast documentation completed.	Site PHMP	

General comments:

Appendix 3: Explosives Management System templates

WHOLE of SITE EXPLOSIVES and BLASTING RISK ASSESSMENT

Mine:	**Team members:**
	Shotfirer representative:
To be completed for overall site and reviewed periodically.	**Date:**

Category		**Risk** H	M	L	**Audit Observations - Controls**
Legislation					
Competencies	Has a competent Shotfirer been engaged to conduct blasts				
	Do all persons having unsupervised access to explosives or explosive precursors have a security clearance				
Licences	If explosives are to be stored, are they stored in licenced premises in accordance with Health and Safety at Work (Hazardous Substances) Regulations 2017, and AS2187				
	Has the risk of theft been considered and a security plan been drafted (if required)				
	Is the site allowed to blast pursuant to its resource consent				

Planning			
Notification	Has community consultation taken place with neighbours prior to blasting		
	Has an exclusion zone been identified		
	Has an agreed notification process to alert the community, employees & visitors that blasting will take place been developed? (Signage, letter drop, verbal, sirens etc.)		
	Has a geotechnical assessment been undertaken to identify potential hazards (Cavities, jointing, faults, weathered material etc.)		
Blasting Hazards			
Flyrock	Do procedures exist to control flyrock to a minimum (Stemming, loading, overcharging.)		
	Do procedures exist to ensure blast designs are 'signed off'		
	Do controls include laser profiling & bore tracking		
	Does the exclusion zone consider all possible flyrock scenarios		
Vibration	Have calculations been completed to model potential vibration levels		
	Are monitoring devices being installed at agreed locations		
Noise (overpressure)	Have calculations been performed to model potential noise/overpressure levels		
	Are monitoring devices being installed at agreed locations		
Dust & fumes	Are adverse weather conditions considered in the modelling		

	Is dust and or fume monitoring required at close residences		
Traffic	Has public and mine traffic been considered in relation to exclusion zones		
	Has a communication strategy been developed to manage all traffic, clearing of exclusion zones and firing requirements		
Managing the Blast Cycle			
Transport	Are vehicles transporting explosives licenced (if on a public road) or maintained to a similar standard (on a mine site)		
	Are procedures in place to exclude non-essential personnel from the blast area (signage, removal of production equipment)		
	Will selected transport routes keep explosives vehicles separated from production equipment as much as possible		
	The site has considered its response to a fire situation where explosives may be present		
Loading	Are procedures in place to control the amount of product that is loaded into each hole		
	Are procedures in place to manage persons working near high-wall benches		
	Are all high-walls protected by a structural barrier or a bund		
	Is the site going to have to manage wet shots (ground water and surface water)		
Firing	Are procedures in place to manage the clearing of exclusion zones		
	Are procedures available to manage ‘misfires’		

	Does the misfire procedure reference AS2187		
	Are procedures in place to ensure that anything capable of generating a fire is not carried out within 10 m of explosives		
Loss of explosives	Has the security of the site been considered, particularly with respect to 'sleeping shots'		
	Has the site got systems in place to identify the loss of explosives and the reporting of the loss to the police and the regulator		
Documentation			
	Will the site be requiring blast specific risk assessments		
	Will the site be requiring SWMS to cover all activities relating to blasting		
	Will the site be requiring a copy of the blast report at the conclusion of the shot		
	Are there copies of explosive legislation, standards, and codes available for persons to refer to:		
	• Health and Safety at Work (Mining and Quarrying) Regulations 2016 • Health and Safety at Work (Hazardous substances) Regulations 2017 • AS 2187 (storage, transport and use of explosives • NZ Extractives Industry Safe Drill & Blast Code of practice		

Blast Specific Risk Assessment Form

Site:		**Date shot commenced:**		**Date fired:**		**Shot Number:**	
Company performing Drilling:				**Name of Driller:**			
Company performing Blasting:				**Nominated Shotfirer:**			
Person supervising drill and blast for mine/quarry:							

(To be completed before work commences)		**Y/N**	**(To be completed before firing commences)**		**Y/N**
Access / layout	Is the access road to the bench adequate (Gradient, edges protected, surface)		**Pre-Initiation**	Has loading occurred as per the blast design (no overloading, slumping, lost holes)	
	Is there appropriate distance from the back row of holes to the high-wall (> ½ the face height)			Has an exclusion zone been established	
	Have all high-walls been scaled and confirmed safe			Is the Shotfirer able to fire the shot without any known risks to people or infrastructure	
	Does everyone have SWMS to cover their work				
			Agreed Alterations to Design (both parties sign to accept changes)	**Shotfirer** -	
Mark-out	Has the face been inspected from below (No undercuts, overhangs, back break)			**Manager** -	
	Is the shot surface reasonably smooth & clear of trip hazards		**Hazards Identified and Implemented Controls** (record actions)		
	Are all edges protected by a structural barrier or a bund		1.		
	Have communication systems been confirmed with the quarry operator		2.		
Drilling	Can the drill rig drill all holes perpendicular to the face		3.		

	Can all holes be drilled on gradients within the capabilities of the drill rig		**SIGN-OFF (All members of blast cycle team to sign off on risk assessment.)**	
	Is there an exclusion zone around the boom of the rig		1.	
	Have all water sources been identified and drawn to the Shotfirer's attention		2.	
Loading	Has the blast area been defined with signage and all non-essential equipment and people removed		3.	
	Can all holes be loaded without a person having to breach the structural barrier or bund to load		4.	
	What fall protection devices will be used ( )		Confirmation of completed Risk Assessment by Manager	(signature)

Managers Blast Checklist

Site:		**Date shot commenced:**		**Date & time fired:**		**Shot Number:**	
Company performing drilling:				**Name of Driller:**			
Company performing blasting:				**Nominated Shotfirer:**			
Person supervising drill and blast for mine/quarry:							

Preparation:	✓ or **N/A**
A copy of the driller's SWMS and / or contractor management plan has been obtained and reviewed	
A copy of the Shotfirer's SWMS and /or Contractor Management Plan has been obtained and reviewed	
All persons have been inducted onto site	
A face & bench stability inspection has been conducted to identify any issues	
The blast design has been completed in consultation with the Shotfirer and agreed upon	
A blast specific risk assessment has been completed	
Edge protection is in place prior to mark out (fencing with structural capability or bunded)	
Measure from the back row of holes to the face behind to verify that final bench width will be as designed, taking account of back break, edge protection required etc.	
Drilling:	
Drilling equipment has been inspected and confirmed 'fit for purpose'	
If the shot is laser profiled, the results have been reviewed and accepted	
If the shot is bore tracked the results have been reviewed and accepted	
A copy of the final drill log has been supplied and reviewed with the Shotfirer	
Where a front hole has deviated toward the face, what is the allowable minimum burden before the load plan is modified	
Is the actual burden along the length of each front hole within the allowable minimum burden	
Has the driller done a risk assessment prior to drilling to ensure the bench being drilled is safe? i.e. Back break, undercut face below or above the driller, steepness of ground	

Blasting:	✓ or **N/A**	**Neighbours Names:**	**"How Notified" (Verbal, mail etc.)**
All neighbours have been notified as per Resource Consent or agreed requirements (record details)		1.	
Environmental monitors have been positioned		2.	
Is the blast going to occur between allowable hours		3.	
Weather conditions are confirmed O.K. to blast		4.	
Blast camera is in position to record shot		5.	
Sentries have been positioned		6.	
All persons on site have been accounted for and are outside of exclusion zone			
Control handed over to Shotfirer		**Monitor Locations:**	
All audible warning sirens have been sounded prior to blast		1.	
Reconciliation between design and actual explosives used, and powder factor, completed and reviewed with Shotfirer		2.	
Has the Exclusion zone been calculated for the shot and is it appropriate for the blast as charged		3.	
Post Blast Inspection:		4.	
No misfires have been identified		5.	
Misfires have been identified, recorded, and dealt with in accordance with an approved 'misfire' procedure		6.	
Shotfirer has handed site back to 'mine operator'			
No environmental exceedances identified		**Regulatory Notifications:**	
Any blast concerns are noted on the blast plan & report		1.	
Regulators have been notified of reportable incidents or exceedances (Flyrock, misfire, faulty product, exceedances)		2.	
A copy of the blast plan & record has been provided to the mine/quarry Operator		3.	