**SAFETY AND HEALTH COMMISSION
FOR THE MINING AND OTHER
EXTRACTIVE INDUSTRIES**

Committee on Surface Workings

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GUIDANCE ON THE SAFE USE OF EXPLOSIVES IN QUARRIES

Report and proposal to the Governments
Of the Member States

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EXPLOSIVES

The operator's key responsibility regarding the use of explosives, as in relation to other risks, is to ensure that the work is properly managed, planned, co-ordinated and supervised. This is the case whether shotfiring operations are undertaken by a quarry worker or by a specialist-blasting contractor.

1. Explosives Supervisors

One person, called in this guidance the explosives supervisor, needs to be placed in overall, day-to-day, charge of work with explosives at a quarry. Exactly who is appointed, as an explosives supervisor will vary. It may, for example, be the quarry manager, another manager or supervisor, a blasting contractor, one of the contractor's employees or an outside consultant.

The explosives supervisor should have sufficient practical and theoretical knowledge and experience for the work, which is to be undertaken. To obtain the necessary theoretical knowledge an explosives supervisor needs, as a minimum, to have successfully completed a course of training covering:

a) Blast calculation and design;

b) Ground vibration, air blast overpressure and flying stones;

c) Shotfiring.

A quarry may need several explosives supervisors to cover all the work, for example where blasting takes place on several shifts. If this is necessary for the working of the quarry:

d) There may only be one person acting as the explosives supervisor at any time;

e) All explosives supervisors must be familiar with the shotfiring operating procedures and the site, as far as that relates to the safe use of explosives; and

f) There needs to be good communication and co-ordination between them, for example to deal with any handover or maintenance issues.

2. Blasting contractors

The operator may appoint a contractor, the blasting contractor, to carry out some or all of the explosives work. The operator is, nevertheless, always responsible for the overall management of the quarry and safe use and security of explosives. The operator is similarly responsible for the shotfiring operating procedures and blast specifications, even if a contractor or consultant actually draws them up.

3. Shotfiring procedures

Shotfiring operating procedures should be set out in writing to ensure that shotfiring operations at the quarry take place without endangering the workforce or the public. They should take proper account of local circumstances, for example any risk of accidental initiation due to radio frequency transmitters, electrically powered plant and overhead power lines. If there is such a risk, a suitable method of initiation must be chosen.

The procedures should be well publicised throughout the quarry, and personal copies given to those who have duties under them. The operator must ensure that arrangements should be made to monitor compliance with the operating procedures.

The operating procedures need to cover arrangements for:

a) The appointment and authorisation of shotfirers, trainee shotfirers, storekeepers and others handling and/or working with explosives;

b) The explosives supervisor to check that:

- The equipment provided is suitable and safe and
- Site conditions are in line with the blast specification before work with explosives;

c) Times when shotfiring is permitted;

d) The determination of the danger zone (which does not include any safe refuge, for example one from which a shot is to be fired, which is deliberately excluded from what would otherwise be the danger zone) likely to be created by the firing of each shot, evacuation of the danger zone and the provision of effective shelters when a shot is tested or fired;

e) Warning systems including, as appropriate:

- The use of flags or notices;
- A system of audible signals, audible throughout the danger zone, to warn people to withdraw from the danger zone and to give the all-clear;
  - the posting of sentries before each shot; and
  - the direct personal notification of local residents who may be affected;
- Inspection of the blast site after firing to check the state of the face and whether a misfire has occurred;

f) Ensuring that normal working is resumed only when the shotfirer is fully satisfied that it is safe and the all-clear has been sounded;

g) Safeguarding charged, but unfired shot holes and explosives left after a misfire, which have not been recovered, at the end of a working day. These arrangements should ensure that someone is in attendance, or within sight of the charged holes, where necessary to prevent theft or unauthorised initiation of the explosives;

h) Dealing with misfires and the discovery of unfired explosives from previous operations. There should always be a competent person available to ensure that any misfire is dealt with safely; and

i) Monitoring arrangements for operations to ensure the operating procedures are complied with.

4. Blasting specification

A blasting specification should be prepared for each blast; it must be tailored for each blast, in view of the conditions on the site.

The specification should be designed to:

(a) Ensure that the risk of fly rock being projected outside the declared danger zone is as low as possible, and should state any special precautions required to achieve this;

(b) Minimise the risk of misfires;

(c) Enable the location of any misfired shots to be determined accurately; and

(d) Ensure that faces are left in a safe condition after a blast.

The specification should take account of:

(a) Experience gained from previous blasts at the quarry;

(b) Any unusual circumstances which are present or likely to arise;

(c) The design of the excavation; and

(d) Shortcomings during drilling, often the cause of rock projections; the specification should have regard to:

- i) A reliable survey of the face; giving details of shot holes (position, angle, depth, direction) in accordance with experience acquired in the deposit.
- ii) During drilling, the intervention of the drill man is essential with regard to:
- iii) Complying with the shotfiring plan
- iv) Identifying and providing information on anomalies encountered during drilling (voids, disruptions, discontinuity in the deposit).

5. Security of Explosives

The arrangements and responsibilities for the storage and security of explosives on site should minimise the risk of loss or theft**.** National standards apply, however, if necessary, additional advice should be obtained from the appropriate authority e.g. police, mining authority.

The keys to the explosives store should be kept safe at all times, either in the custody of a suitable person the explosives supervisor, shotfirer or explosives storekeeper, or in a secure place.

To ensure the safety and security of the explosives there should be appropriate arrangements for authorising all movements of explosives to and from the place of use. On site, the identified authorised person usually supervises arrangements. Only authorised people should handle explosives at a quarry.

There should be a storekeeper. The duties of the storekeeper in charge of the explosives store should include:

(a) The security and safe storage of explosives, including detonators;

(b) The custody of keys;

(c) Record keeping in a designated stock book;

(d) The issue and receipt of explosives; and

(e) Immediately reporting any loss or theft of explosives to a suitable designated person.

6. Custody of explosives, etc.

Explosives should remain under the control of suitable and authorised people, such as a shotfirer or trainee shotfirer. They must remain under the control of such a person.

There should be containers for detonators, which should be fitted with secure locks. Electrically operated detonators should be stored so that they are electrically isolated, with no part of any detonator or lead exposed. The container should be lined with shock absorbing, anti-static material, kept clean and used only for detonators. Containers should be unlocked for as short a time as possible — only while detonators are actually being inserted or removed.

Other explosives should be carried in the manufacturer's packaging or other suitable, robust containers, and removed from the packaging or container only immediately before use.

Ammonium nitrate needs to be kept in weatherproof and well-ventilated conditions. It should be protected from contamination by fuel oil or other organic material. This can usually be achieved by keeping it 25 metres away from any stored explosives, fuel or lubricating oil. To minimise the risk of fire the surrounding area needs to be kept clear of grass, shrubbery, spilled fuel oil, or other organic material.

Where deliveries of explosives (including detonators) are made directly to the blast site, the shotfirer needs to check the delivery note to ensure that the quantities are correct, sign for them and ensure that they are not left unattended. The detonators should be transferred to suitably constructed detonator containers as soon as possible. To enable accurate record keeping, the delivery note should be passed to the person in charge of the explosives store.

Care should be exercised to ensure that all explosives and detonators, even for short-term keeping outside an exploves store, are always in the care of an authorised person.

7. Disposal of empty cases and deteriorated explosives

There should be arrangements to check that no explosive remains hidden or lodged within any explosives cases before disposal. Manufacturers can advise on the removal or destruction of deteriorated explosives.

8. Use of vehicles to transport explosives, etc.

Parts of vehicles where explosives are carried should be kept clean and free of grit. Detonators should be kept in appropriate containers and enclosed in a strong, locked compartment when they are being carried on a vehicle. Explosives should be loaded safely, so that they cannot fall out of the vehicle.

Nothing, which creates a fire or detonation risk, should be carried on a vehicle containing explosives or ammonium nitrate. Anything else, which is carried, should be safely stored, normally in suitable separate compartments or containers. It is good practice to ensure that only essential shotfiring equipment, e.g. circuit testers, stemming rods and shotfiring cable, is carried on such vehicles.

All vehicles transporting explosives in the quarry should be provided with sufficient, suitable fire extinguishers. They should also be easily recognisable from a distance, for example, by means of signs, distinctive flashing lights or flags.

Trailers should have efficient brakes and a properly designed rigid tow bar with a safety chain, which will cause the brake to be applied in the event of separation.

9. Provision and maintenance of equipment

The equipment provided for shotfiring operations should be suitable and properly maintained. Inspection and maintenance arrangements must be set out.

A competent person should check the equipment provided, before use, to ensure that it is suitable and safe,. Any equipment, which is not safe, should be taken out of use.

10.Shotfiring equipment

Circuit testers should be capable of measuring the resistance of the circuit without any adverse effect to the detonators. Where transformer coupled electric detonators are used, an impedance test facility is required. This often forms an integral part of the exploder.

Exploders and circuit testers should have detailed inspection, including appropriate tests, at periods specified by the manufacturer or every six months, whichever is shorter. Such inspection is also needed after any significant repair or an unexplained misfire.

Inspections and tests should be designed to ensure that suitable exploders, adjustable to the resistance of the shotfiring circuit, and circuit testers are in good order and meet their designed performance ratings; and that exploders can fire shots up to their rated capacities. A record of the results of any inspections and tests should be retained for a suitable period.

Tools used for piercing cartridges, mixing explosives or in shot holes (e.g. for charging, stemming or testing) should be made of non-sparking materials such as wood, antistatic plastic or non-ferrous metal.

Electric detonators should not be used inside shot holes where there is a risk of premature detonation due to the build up of a static electric charge or if an electrical storm is expected. This is an issue when, for example, shot holes are lined with a plastic sleeve or where rigid plastic containers are used, unless the lining is antistatic.

To reduce this risk, stripped parts of detonator wires and the shotfiring cable must be short-circuited by twisting the ends of the wires or cables.

Shotfiring cables must be separated from all electric cables (e.g. excavator feed cable) to avoid any risk of induction.

Explosives mixing trucks should be earthed during mixing and transfer operations to dissipate static charges.

Delay detonators should be clearly marked with the period of delay when supplied. This period should, preferably, also be marked on the detonator lead.

11. Shotfiring Operations

Shotfirers should ensure that shotfiring operations are conducted in accordance with the operating procedures and the blasting specification.

Explosives mixed on site should be mixed where they are to be used and only in sufficient quantities for immediate use.

The shotfirer should be fully satisfied that each shot hole has been drilled and charged in accordance with the blasting specification. The rise of explosives in holes should be checked at regular intervals to ensure that the shot hole is being correctly charged.

If it is not possible to conform to the specification, or the danger zone appears to be different from that shown, shotfiring operations should be suspended until any change to the specification has been authorised by its author or other suitable person.

The shotfirer should only connect a tester to a shotfiring circuit when ready to test or fire the shot. The exploder should be disconnected immediately after firing or in the event of an unsatisfactory test on the firing circuit. No one but the shotfirer should be able to operate the exploder.

Workers should obey any relevant instructions in relation to shotfiring operations, for example from the shotfirer or sentry. Sentries are there to keep people out of the danger zone and should not leave their post until the all-clear signal has been given, or until the person who posted them releases them.

12. Avoidance of misfires

Connections should be checked immediately before a blast to ensure the integrity of the system and to minimise the risk of a misfire. Where in-hole initiation is used, i.e. with the detonator placed inside the hole, two detonators are recommended for each deck or column of explosives to minimise the possibility of a misfire. This is because faulty detonators cannot be easily identified or recovered.

Shock tube connectors should be covered with sufficient material to prevent damage to surface lines by shrapnel; about 200 millimetres of damp dust or chippings is usually sufficient.

13. Use of safety fuse

Safety fuse should be of such quality that the rate of burning is between 90 and 110 seconds for each metre of fuse. It is recommended that a shotfirer should not attempt to ignite more than six lighting points at any one time. When igniter cord is being used to connect lengths of safety fuse, the initiation system should be such that the last length of safety fuse has started to burn before the first detonation occurs.

14. Safe use of explosives

Only one container of explosives should be open at a shot hole at any one time. Explosives should not be used on or inside machinery, e.g. clearing blockages, except where all other means, for example hydraulic breakers, have failed.

Explosives should not be taken into a room or other place where people congregate, or where there is a possible source of initiation, for example machinery, electrical equipment or a naked flame.

15. Charging shot holes etc.

Where explosive cartridges are used the shotfirer, before charging a shot hole, should check, using a probe that its section is not obstructed and explosive cartridges can pass through.

During charging the height of the explosive in the hole should be checked in order to detect any losses in cavities or an excessive level of charge in relation to the envisaged stemming height. A plumb line is often used to carry out this check.

It is essential that the shotfirer should be present during charging. Detonators, other explosives and charged holes should not be left unattended. All detonators should be locked in their containers.

Any surplus explosives (including detonators) should be removed from the blast area before any attempt is made to fire the shot. The shotfirer should ensure that surplus explosives are not left unattended. They should be returned to the explosives store at the earliest opportunity, not later than the end of the shift, and the records amended accordingly.

16. Training of Shotfirers

All shotfirers should possess sufficient practical and theoretical knowledge and experience to perform their full range of duties. Shotfirers should not be appointed unless they have had successfully completed a suitable course of training.

A trainee shotfirer should work under the close personal supervision of an experienced shotfirer, with the trainee following a programme of practical instruction by the shotfirer. A written training programme, which is given to, everyone involved helps ensure that the training is well structured. The training should continue until the necessary competence has been acquired and demonstrated.

17. Appointments and authorisations

The shotfiring operating procedures should set out arrangements for the appointment of those who shotfirers, trainee shotfirers and storekeepers and for authorisation of others to work with explosives. The operator, or the blasting contractor if there is one, may make the appointments or authorisations depending on what is required by the operating procedures.

As part of ensuring competence, references should be taken up to check that a new shotfirer has sufficient experience and knowledge. An on-site interview and practical test of the applicant's abilities are also needed before anyone is given a job as a shotfirer.

18. Misfires

All misfires should be investigated to determine the cause and to enable action to be taken to avoid any recurrence. The blasting specification, endorsed with details of any misfire, would be a suitable record of misfires.

19. Visibility

Visibility, including during the hours of darkness, should be adequate for the blast and other associated work to be carried out safely. This can, largely, be achieved by stating what time a blast may be carried out in the blast specification. The timing should allow for any inspections required before or after the blast. Fog, rain and snow may reduce visibility and make it unsafe to blast. The effect of such factors should be addressed in the shotfiring operating procedures and, if necessary, also in the blast specification. In addition to the visibility considerations, the nuisance it may create to neighbours should influence the timing of the blast.