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Code of practice for the safe use of explosives in the construction industry



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Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 October 2017. It was prepared by Technical Committee B/513, *Construction equipment and plant, and site safety*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This British Standard supersedes BS 5607:1998, which is withdrawn.

Information about this document

This British Standard sets out good practice for the handling, transport and storage of explosives during the varied uses to which explosives can be put by the construction industry. Emphasis throughout the standard is on safety, particularly the safety of those engaged in using explosives for work on site and the safety of others who can be in the vicinity of that work.

While the importance of security is recognized, this British Standard does not give detailed recommendations for security measures.

This is a full revision of the standard, and introduces the following principal changes:

- elements of text have been updated to reflect changes in the statutory regulations applicable to the use of explosives;
- recommendations have been updated to reflect changes in technology since 1998; and
- greater emphasis is given to the qualifications and general competence of shotfirers and explosives engineers.

Hazard warnings

WARNING. This British Standard calls for the use of substances and/or procedures that can be injurious to health and safety if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety or the acquisition, handling or storage of explosives at any stage.

Use of this document

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this British Standard is expected to be able to justify any course of action that deviates from its recommendations.

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to people appropriately qualified, experienced and authorized people who are competent in explosives operations, including handling explosives, blast design or approval of blasting procedures (see [Clause 8](#)), for whose use it has been produced.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is “should”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

The word “should” is used to express recommendations of this standard. The word “may” is used in the text to express permissibility, e.g. as an alternative to the primary recommendation of the clause. The word “can” is used to express possibility, e.g. a consequence of an action or an event.

Notes and commentaries are provided throughout the text of this standard. Notes give references and additional information that are important but do not form part of the recommendations. Commentaries give background information.

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. “organization” rather than “organisation”).

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

In particular attention is drawn to the following specific regulations:

- The Explosives Act 1875 [1];
- The Explosives Act (Northern Ireland) 1970 [2];
- The Health and Safety at Work etc. Act 1974 [3];
- The Health and Safety at Work (Northern Ireland) Order 1978 [4];
- The European Agreement concerning the International Carriage of Dangerous Goods by Road 2017 (ADR) [5];
- The Construction (Design and Management) (CDM) Regulations 2015 [6];
- The Construction (Design and Management) Regulations (Northern Ireland) 2016 [7];
- The Explosives Regulations 2014 (as amended) [8];
- The Management of Health and Safety at Work Regulations 1999 [9];
- The Management of Health and Safety at Work Regulations (Northern Ireland) 2000 [10];
- The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013 (RIDDOR) [11];
- The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (Northern Ireland) 1997 [12];
- The Health and Safety (Safety Signs and Signals) Regulations 1996 [13];
- The Health and Safety (Safety Signs and Signals) Regulations (Northern Ireland) 1996 [14];
- The Control of Substances Hazardous to Health Regulations 2002 [15];
- The Quarries Regulations 1999 [16];
- The Quarries Regulations (Northern Ireland) 2006 [17];
- The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (as amended) [18];
- The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations (Northern Ireland) 2010 [19];
- The Dangerous Substances and Explosives Atmospheres Regulations 2003 [20];

- The Ammonium Nitrate Materials (High Nitrogen Content) Safety Regulations 2003 [21];
- The Manufacture and Storage of Explosives Regulations (Northern Ireland) 2006 [22];
- The Dangerous Goods in Harbour Areas Regulations 2016 [23];
- The Dangerous Substances in Harbour Areas Regulations (Northern Ireland) 1991 [24];
- The Control of Major Accident Hazards Regulations 1999 [25];
- The Identification and Traceability of Explosives Regulations (Northern Ireland) 2010 [26].

NOTE 1 These regulations are regularly amended, so it is necessary to ensure that the latest version of each is applied. Attention is drawn to local regulations in overseas jurisdictions.

NOTE 2 All legislative requirements relating to explosives in Great Britain form “relevant statutory provisions” as defined in the Health and Safety at Work etc. Act 1974 [3].

Section 1: Preliminary processes

1 Scope

This British Standard gives recommendations for the safe storage, handling, transport and use of blasting explosives and accessories in construction and demolition operations.

[Section 1](#) covers general recommendations for handling and safety.

[Section 2](#) is concerned with safety in the use of explosives in special applications and situations such as tunnelling, demolition, excavation and underwater working.

This British Standard is not applicable to:

- a) blasting on offshore oil and/or gas platforms or structures, or any associated works;
- b) underground works carried out for the purpose of exploiting mineral reserves and extensions to voids left following ore extraction, which are governed by mining legislation; or
- c) operations involving the use of cartridge-operated fixing tools, which are specified by BS EN 15895 and whose use is covered by BS 4078-1.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes provisions of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Standards publications

BS 5930, *Code of practice for ground investigations*

BS 5975, *Code of practice for temporary works procedures and the permissible stress design of falsework*

BS 6031, *Code of practice for earthworks*

BS 6164, *Code of practice for health and safety in tunnelling in the construction industry*

BS 6187:2011, *Code of practice for full and partial demolition*

BS 6472 (both parts), *Guide to evaluation of human exposure to vibration in buildings*

BS 7385-1, *Evaluation and measurement for vibration in buildings — Part 1: Guide for measurement of vibrations and evaluation of their effects on buildings* (withdrawn)

BS 7385-2, *Evaluation and measurement for vibration in buildings — Part 2: Guide to damage levels from groundbourne vibration*

BS EN 13763-26:2004, *Explosives for civil uses — Detonators and relays — Part 26: Definitions, methods and requirements for devices and accessories for reliable and safe function of detonators and relays*

BS EN 16228 (all parts), *Drilling and foundation equipment — Safety*

ISO/DIS 19296, *Mining and earthmoving machinery — Mobile machines working underground — Machine Safety*

Other publications

[N1] HEALTH AND SAFETY EXECUTIVE. *Explosives Regulations 2014. Safety provisions. Guidance on Regulations. Approved Code of Practice L150*. Sudbury: HSE Books, 2014

[N2] HEALTH AND SAFETY EXECUTIVE. *Explosives Regulations 2014. Guidance on Regulations – Security provisions. Approved Code of Practice L151*. Sudbury: HSE Books, 2014

[N3] HEALTH AND SAFETY EXECUTIVE. *Health and safety at quarries. The Quarries Regulations 1999. Approved Code of Practice L118*. Sudbury: HSE Books, 2013

[N4] MINERAL PRODUCTS ASSOCIATION. *Positioning a shotfiring shelter: Guidance on what to consider when positioning a shotfiring shelter*, London: Mineral Products Association, 2009

3 Terms and definitions

For the purposes of this British Standard, the following terms and definitions apply.

3.1 air overpressure

production of increased air pressure as a result of an explosion

3.2 ANFO

mixture of ammonium nitrate and fuel oil that can be used as an explosive

NOTE The preparation of ANFO is required to conform to the licensing provisions of *Explosives Regulations 2014* [8], Regulation 6.

3.3 approved

authorized for use by an authority having jurisdiction

3.4 black powder

gunpowder used in blasting

3.5 blast area

area within which all the debris from the blast is expected to fall and come to rest

3.6 blast plan

charging plan and, where applicable, the drilling pattern

3.7 blowdown

reduction and demolition of a structure by the controlled use of explosives

3.8 blowdown manual

detailed programme of tasks and their sequence developed as part of the overall project planning

NOTE The blowdown manual includes the definition of the event control team with roles and responsibilities, planning of all activities related to the event, liaison with emergency services, exclusion zone control, evacuation of persons at risk, placement of protection locally and remotely to the blast area, detailed sequence of events leading up to, during and post-blast, contingency arrangements, standby services, etc.

3.9 bulk explosives

explosives that fill the complete cross section of a shot hole to provide 100% coupling with the substrate

3.10 burden

shortest distance between explosives and any free face

3.11 canister

portable container specifically intended and designed to carry a small quantity of explosives or accessories

3.12 capped fuse

length of safety fuse crimped into a plain detonator

3.13 cartridge

wrapped or otherwise protected cylinder of defined size of a homogeneous explosive material

3.14 competence

combination of training, qualifications, skills, experience, knowledge and other qualities that an organization or individual has to allow them to perform a task assigned to them properly and safely

3.15 deflagrating compounds

materials which enable the subsonic propagation of a reaction front

3.16 delay detonator

detonator (see [3.18](#)) with a predetermined delay between initiation and detonation

3.17 detonating cord

flexible cord of spun textile fibres containing a core of high explosive [e.g. pentaerythritol tetranitrate (PETN)], and with an extruded plastics (waterproof) coating, which, when initiated, propagates a detonation along its length

NOTE There is a significant explosive effect outside the cord as the detonation propagates (see also [3.45](#)). Several strengths or explosive loadings are available.

3.18 detonator

initiator for explosives materials that contains a charge of high explosive fired by means of a flame, spark, electric current (including an electronic signal) or shock tube

NOTE An American synonym is “cap”, which is deprecated.

3.19 electric detonator

fusehead crimped into a non-electric (plain) detonator; the fusehead being connected to two electric leading wires

NOTE A fusehead is formed by depositing a pyrotechnic mixture over a bridge wire. When a voltage is applied to the leading wires and an adequate current flows, the bridge wire heats up and initiates the fusehead, which in turn causes the detonator to fire.

3.20 electronic detonator

detonator for which the user can preset the delay interval by means of a bespoke initiation system

3.21 emulsion explosive

waterproof explosive that contains sensitizers, oxidizers and fuels dispersed as an emulsion

3.22 exclusion zone

zone from which all site personnel and the public are excluded

NOTE In certain situations the shotfirer may be positioned within the exclusion zone provided that they are protected.

3.23 exploder

device designed for initiating detonators

3.24 explosive

article, substance or mixture of substances that is manufactured to produce a practical effect by explosion

3.25 explosives engineer

competent engineer responsible for the design, control and on-site execution of the explosive event

NOTE An explosives engineer who meets the criteria of the Quarries Regulations 1999 [16] is referred to by the Regulations as an "explosives supervisor".

3.26 explosives store

building, enclosed area or metal structure in which explosives are, or are to be, stored

[SOURCE: The Explosives Regulations 2014 [8]]

NOTE The licensing arrangements are set out in the Explosives Regulations 2014 [8].

3.27 explosives storekeeper

person responsible for the safe operation of an explosives store, including the receipt, issue and stock control of the explosives in it

3.28 fly rock

material projected beyond the exclusion zone

3.29 fume characteristics

nature of fumes produced by the detonation of an explosive, particularly the noxious gases contained therein

3.30 high explosive

explosive that detonates and produces an intense shock wave

3.31 low explosive

explosive that produces large volumes of gases without creating an intense shock wave

3.32 Misfires**3.32.1 type A misfire**

misfire in which testing before firing a shot reveals broken continuity which cannot be rectified

3.32.2 type B misfire

misfire in which any shot fails to explode when an attempt is made to fire it

3.33 NG (nitroglycerine) explosive

explosive that contains nitro-cellulose

3.34 Permitted explosives and detonators

3.34.1 permitted explosive

explosive of a type approved by the Health and Safety Executive for use in safety lamp mines

3.34.2 permitted detonator

detonator of a type approved by the Health and Safety Executive for use in safety lamp mines

3.35 plain detonator

aluminium tube open at one end and with a small charge of a mixture such as lead azide/lead styphnate pressed on top of a slightly larger base charge such as tetryl, cyclotrimethylene trinitramine (RDX) or pentaerythritol tetranitrate (PETN)

3.36 pre-splitting

blasting technique to minimize overbreak by creating a fracture plane on the perimeter of an excavation using shot holes which are fired simultaneously before the main shot holes and which are lightly charged and closely spaced

3.37 primary blasting

blasting by which material is dislodged from its original location

3.38 primer

cartridge or cast primer of explosive or other material into which one or more detonators or detonating cord is inserted or attached, in order to initiate or boost a larger charge

3.39 round

group of shots fired in one operation

3.40 safety fuse

flexible cord that contains an internal burning medium by which fire is conveyed at a continuous and uniform rate for the purpose of firing plain detonators or black powder, without initiating burning in a similar fuse that might be in lateral contact alongside

3.41 secondary blasting

blasting to reduce oversize material to the dimensions required

3.42 sensitivity

measure of ease with which a substance or article can be made to explode, or its liability to explode, when subjected to deliberate or accidental shock, friction or heat

3.43 shaped charge

explosive device designed to concentrate the explosive force in a particular plane or direction

NOTE A shaped charge is sometimes known as a cavity or hollow charge.

3.44 Shelters

3.44.1 blast shelter

protective structure for use below ground in which a shotfirer and others involved in the blasting operations can shelter from blast fume

3.44.2 shotfiring shelter

robust protective structure for use above ground, in which a shotfirer can shelter from fly rock whilst firing shots

NOTE A shotfiring shelter can also be sufficiently large to accommodate other workers involved in the blasting operations.

3.45 shock tube

flexible tube coated on the inside with a reactive composition that, when initiated, propagates a shock wave along its length and initiates a detonator

3.46 shock tube detonator

length of shock tube (see 3.45) crimped into a plain detonator, possibly containing a delay element located between the end of the shock tube and the explosive charge

3.47 shotfirer

appropriately qualified and competent person appointed to be in immediate control of the shotfiring operations which include checking to ensure that the blasting specification is still appropriate for the site conditions at the time blasting is to take place; mixing explosives; priming a cartridge; charging and stemming a shothole; linking or connecting a round of shots; withdrawal and sheltering of persons; inspecting and testing a shotfiring circuit; firing a shot; and checking for misfires

3.48 smooth blasting

blasting technique to minimize overbreak in which a number of shot holes, lightly charged and closely spaced, are positioned on the perimeter of an excavation and fired simultaneously after the main blast but in the same round

3.49 Signals

3.49.1 all clear signal

predetermined visual and/or audible signal given after an explosion after checking that there have been no misfires and the area is safe to enter

3.49.2 warning signal

predetermined visual and/or audible signal prior to the initiation of an explosion

3.50 slurry explosive

waterproof explosive which contains sensitizers, oxidizers and fuels dispersed in a gel

3.51 stemming

inert, incombustible material used to confine explosives in a shot hole

3.52 tunnelling operation

works where drilling and blasting are used for the excavation of underground spaces and the means of access thereto

4 Preliminary procedures

4.1 General

All uses of explosives should be preceded by:

- a review of the relevant legal framework to ensure the proposed procedure is lawful (see [4.2](#));
- a risk assessment to identify potential hazards arising from the work ([Clause 6](#));
- completion of a method statement ([Clause 7](#)) to address the risks identified by the risk assessment;
- identification of those with responsibility and supervisory control of the operation and responsibility for completing the method statement ([Clause 8](#)).

NOTE It may be decided that the use of explosives is inappropriate and an alternative approach is required.

To complete the preliminary procedures, site survey(s), blast design and development of the method statement ([Clause 7](#)) should be carried out.

4.2 Legal framework

4.2.1 Statutory regulations

Persons responsible for the management or supervision of work with explosives should be familiar with the requirements of the Explosives Regulations 2014 [8] and their accompanying guides [27, 28, 29, 30, 31, N1, N2].

Although Parts 2 and 3 of the Construction, Design and Management (CDM) Regulations 2015 [6] apply to most explosives work within the construction industry, their principles should be adopted for all explosives work.

NOTE 1 Regulation 24 of the CDM Regulations 2015 [6] applies to all explosives work in the construction industry.

NOTE 2 Although the Quarries Regulations 1999 [16] do not apply directly to civil engineering construction, Part V, along with the relevant section of the accompanying Approved Code of Practice [N3], contains much useful information on the safe use of explosives.

Special regulations could apply in Scotland, Northern Ireland, the Channel Islands, Isle of Man and the Scilly Isles, and should be checked prior to operations in these areas.

4.2.2 Local authority powers of control

Certain local authorities have special powers of control granted under local act of parliament, from whom permission should be obtained before blasting takes place.

5 Role of the client

COMMENTARY ON CLAUSE 5

For the purposes of this British Standard, the client is the party with overall control of the work on site. This could be the client as defined in the CDM Regulations 2015 [6], including professional advisers, but is more likely to be the principal contractor, including professional advisers. The role of the client may be different for different types of explosives work as these vary in complexity and risk potential, as shown in the following examples.

- a) *The use of explosives in tunnelling and land blasting tends to be characterized by repetitive, relatively straightforward blasts of a similar and generally predictable nature each time. The immediate client for the blasting operation is often a civil engineering contractor and the blasting*

operation can be undertaken by that contractor or by a specialist subcontractor. The purpose of the blasting is to fragment rock for subsequent excavation and transport. The main high-consequence risk arises from the blasting process being inadequately conceived or undertaken.

- b) The use of explosives in the demolition of structures is characterized by specifically-designed blowdowns of a complex nature, often involving structures which have been deliberately pre-weakened. There can be a requirement for a specialist structural engineer, experienced and competent to design the pre-weakening scheme. The explosive demolition contractor is likely to be a specialist for this type of high-hazard work. The intention of the explosive demolition is to mobilize the already pre-weakened structure and to cause it to collapse under gravity and break up. Pre-weakening can be achieved by different techniques, including mechanical, or using specialized explosive cutting charges to achieve the purpose of pre-weakening the structure in part or in full before mobilization of the structure occurs. The appropriate choice of technique should be made by the competent shotfirer to ensure the risks are as low as reasonably practicable (ALARP).*

The main low-frequency but high-consequence risks include the premature collapse of the structure, a fault in the blasting operation, the failure of the blast to bring down the structure either totally or in part, the collapse of the structure in an unplanned location and the failure of the structure to break-up.

5.1 General

The client should ensure that the recommendation of this British Standard, the HSE guidance on the Quarries Regulations [N3] and the Institute of Quarrying's practices, and other forms of relevant good practice (RGP) are followed to ensure safety.

The client should ensure coordination between the parties and that the demolition project is carried out safely.

5.2 Demolition works

COMMENTARY ON 5.2

The client is legally obligated to ensure that the works are carried out safely. This can be met by not only discharging those legal requirements, but also ensuring that the works are undertaken in a manner that meets the relevant good practice within the industry and as set out in this British Standard.

5.2.1 Access to professional advice

The client should be able to demonstrate that it is an "intelligent customer" and should either:

- a) have access to advice from professional advisers within its own organization who are competent in the use of explosives for demolition; or
- b) if the client does not have access to such advice in-house, engage professional advisers competent in the use of explosives appropriate to the client's requirements for the scale of the hazards and risk for comparable projects.

The advisers should provide the appropriate advice and guidance upon which the client should make informed decisions and judgements to ensure the works are carried out safely.

5.2.2 Contractor selection

The client (this term includes the client's professional advisers) should produce an invitation to tender, providing suitable and sufficient information to enable contractors who specialize in the use of explosives for demolition to produce tenders for undertaking the works.

The client should review the adequacy of each tender in accordance with the client's tender assessment procedures, so as to make a judgement on the adequacy of each tender, taking account of:

- a) the safety and technical adequacy of the tender, including but not limited to:
 - 1) the design of any pre-weakening works undertaken as part of the tenderer's proposal; and
 - 2) the tenderer's outline risk assessment, method statement and design of exclusion zone reduce the risks to as low as reasonably practicable;
- b) the tenderer's demonstration of suitability, competence and experience to undertake the type of work required;
- c) the tenderer's proposals for adequate site supervision during work on site to ensure compliance with the design assumptions, along with technical and quality requirements;
- d) the tenderer's change management procedures for addressing design changes or changes in the method of carrying out the works on site, including independent [Category (CAT) 3] checking before submission for approval by the client;
- e) any areas of risk or topics either missing or of insufficient detail in the tender, and the implications and potential consequences of these omissions for the safety of the works; and
- f) the client's learning from experience of similar or relevant projects, the information from which could benefit the client's judgement as to whether the works can be undertaken safely.

The client should then undertake a process of review internally and, where appropriate, involve an independent review undertaken by a competent third party (sometimes referred to as a CAT 3 check).

Any learning experience identified by the client [see f)] should be passed on to appropriate parties, particularly if occurring during the tender process.

The client, appropriately informed in accordance with a) to f), should then select a suitable explosive demolition contractor based on the evidence from the tender review. The client should keep a formal record of the selection decision-making process.

5.2.3 Post-award of contract

A project-specific risk register should be drawn up between the client, any designers and the explosive demolition contractor, setting out all reasonably foreseeable risks arising from the proposed works. The client, with advice from the professional advisors as necessary, should confirm the allocation of responsibility for control of identified risks between the parties to clearly establish which party is in control of each of the identified risks, along with the communications channels between the parties.

NOTE It is recognized that this risk allocation might include statutory requirements, as well as contractual obligations with some forms of contract.

The explosive demolition contractor should develop the detailed proposals for a robust technical design, including comprehensive risk assessments and method statements that address the full scope of the works.

The client should ensure the explosive demolition contractor's detailed proposals are in accordance with relevant good practice such as set out in this British Standard and in compliance with the law. Any shortfalls should be addressed within a formal change control process (see [5.2.5](#)) by the explosive demolition contractor, and submitted for further review by the client and potential acceptance before the works proceed safely on site.

5.2.4 Supervision on site

The client should make suitable and appropriate arrangements for the supervision of the explosive demolition contractor's implementation of the design. This should be in addition to the explosive demolition contractor's own arrangements for supervising their works.

The level of client's supervision should be appropriate and proportionate to the hazards and risks involved in the explosive demolition contractor's undertaking of the works.

Where appropriate, the client should retain access to professional advisers to provide additional supervisory cover during the project lifetime.

Where appropriate, the client should liaise with, and develop and maintain clear lines of communication and responsibility with, third parties such as statutory services, adjacent site owners, the public and enforcing authorities, in order to ensure the works are undertaken safely.

The client should make suitable arrangements for managing those risks outside the responsibility of the explosive demolition contractor, but are within the client's direct control, during the implementation of the works.

5.2.5 Changes to the explosive demolition contractor's proposal

The client should develop appropriate arrangements for reviewing proposed changes in the constructor's design or methodology and for ensuring that these changes are subject to an appropriate change management process with a robust technical peer review by the client, which may result in additional CAT 3 checking if necessary, before the proposed change is formally presented to the client to make a judgement on the adequacy of that change.

Any design changes should then be incorporated into an updated version of the explosive demolition contractor's method statement and the updated documents issued to site under both the contractor and the client's processes and arrangements for document control.

6 Risk assessment and site survey

6.1 Risk assessment

COMMENTARY ON 6.1

The Management of Health and Safety at Work Regulations 1999 [9] require that an assessment of risks is carried out and that the risk mitigation measures identified by that assessment are acted upon in any subsequent operations.

Risk assessments should:

- a) identify the significant risks arising out of the work, including those to third parties not directly involved in the blasting operation;
- b) enable identification and prioritization of the measures to be taken to comply with the relevant statutory provisions; and
- c) be appropriate to the nature of the work and be such that they remain valid for a reasonable period of time.

All risk assessments/method statements and amendments should be recorded in writing.

Risk assessments should include and take cognizance of the general considerations of [6.2](#) to [6.6](#), but should not be limited by them.

6.2 Site survey

6.2.1 General

Before any works involving the use of explosives are started, a detailed survey and examination of the site, buildings or structures and adjoining areas and property should be carried out in accordance with BS 5930. When earthworks, tunnelling or demolition are involved, the relevant recommendations of BS 6031, BS 6164 and BS 6187, respectively, should be followed. Where temporary works, including pre-weakening, are involved, these should be carried out in accordance with BS 5975.

6.2.2 Geological structure

Where rock samples have been obtained during a ground investigation, the geological findings from these samples should be incorporated into the blast design. This gives the structure to proceed with a trial blast, and the blast parameters should then be modified depending on the outcome of the trial blast.

The character and structure of the geological strata present on site, and how they will react to blasting, should be established. Additionally, the interaction of the geological structure with excavations or cuttings should be determined, and the stability and safety assessed.

6.2.3 Utilities and underground structures

The proximity of underground and overground services should be accounted for before blasting operations are carried out. Consultations should be carried out by the client or delegated responsible person or organization with the relevant bodies who are responsible for existing utilities on appropriate protection and action levels, e.g. for vibration, air overpressure levels. This information should then be passed on to the contractor during the tender period.

Care should also be taken to avoid disruptions or damage to underground features such as utilities, wells, tunnels, storage tanks, mine workings and other voids.

6.2.4 Ground/airborne vibrations

The proximity of buildings or structures, such as bridges, retaining walls and underground services, should be accounted for before blasting operations are carried out.

Owners and occupiers of the buildings/structures/services concerned should be consulted, to determine the sensitivity of the buildings/structures/services/associated equipment to ground-borne vibration from blasting and their concerns about potential damage to their property.

NOTE Human beings are very sensitive to vibration and can perceive vibration levels of a very low order, which can lead to complaints during production blasting operations.

Vibration levels should be minimized by appropriate explosives and collapse design. Where necessary, a contractual limit should be specified or the recommendations of BS 7385-1 (withdrawn), BS 7385-2 and BS 6472 (both parts) should be followed to minimize damage from vibration and human exposure levels to vibration. Where ground or airborne vibrations could constitute either a nuisance or a potential damage risk, structural surveys should be undertaken before and after blasting.

Initial trial blasting, along with vibration monitoring, should be carried out with small isolated charges to allow the transmission properties of the ground in that particular location to be characterized and the vibration effects from blasting calculated with a degree of confidence.

6.3 Hazards from electrical sources

The presence of power cables and radar, radio and television transmitting stations near intended blasting operations should be determined, and the potential hazard posed by them assessed, since under special conditions these can cause premature firing of electric detonators (see BS 6657). On-site use of radio transmitters and mobile telephones should be strictly controlled during blasting operations.

NOTE Premature initiation can also result from electrical discharges, for example, direct lightning strikes or from resulting stray currents of sufficient magnitude. Additional hazards and risks arise from drones.

Presently, no initiation system offers complete protection against direct lightning strikes, so if a lightning storm approaches a blast site charging should cease and the blast area should be vacated of all personnel. If stray currents from any sources are foreseeable, initiation systems offering protection should be employed, for example, non-electric systems.

Extreme caution should be exercised when using electric detonators adjacent to public highways as illegal over-powered transmitters could be carried on vehicles passing close to the area of blasting. Electronic systems or other intrinsically safe means should be adopted. Where any doubt remains, electrical means of firing should not be used.

6.4 Exclusion zone and warning procedures

The extent of the exclusion zone and the necessary blast warning procedures should be assessed as part of the risk assessment, to ensure that the risk of injury to contractor's personnel, third parties and members of the public is reduced to as low as reasonably practicable.

NOTE Under the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) 2013 [11], the projection of material beyond the limit of exclusion is a reportable incident.

6.5 Sources of ignition and fire

An assessment should be made of the possible presence of sources of ignition and fire, e.g. the use of flame or heat-producing equipment, smoking, waste paper, dry timber and vegetation in proximity to the explosives store, and the potential need to burn rubbish on site (see 9.3.6 for control measures).

6.6 Advance notices and consultation

Prior to carrying out the works, the relevant authorities should be consulted and advance notification given, along with periodic updates as appropriate, to:

- a) owners or occupiers of any premises which are likely to be affected by the blasting events;
- b) police;
- c) local authority;
- d) Health and Safety Executive;
- e) the Office of Nuclear Regulation;
- f) local residents;
- g) highways and roads authorities;
- h) fire authority;
- i) other interested or affected parties.

Consultations should be at agreed intervals through the planning process.

7 Method statement

7.1 General

Before any work commences on site, a method statement based on the blast design and associated risk assessments (see [Clause 6](#)) should be prepared by the contractor. Where appropriate, the method statement should be developed in stages, with the overall design adjusted and refined on the basis of information gathered from structural assessments/investigations and trial blasts [see [6.2.2](#) and [6.2.4](#)]. The method statement should be proportionate to the scale and complexity of the project, and reflect the level of potential risk.

Drawing up a method statement should be seen as an essential step in demonstrating compliance with the requirement of Section 2(2) of the Health and Safety at Work etc. Act 1974 [[3](#)] to provide a safe system of work.

The method statement should also include procedures and practices drawn from instructions and site rules specified by the company, to ensure compliance with current legislation, codes of practice and guidance notes. It should identify problems and their solutions, and form a reference for site supervision. The method statement should be easy to understand, and be known and agreed by all levels of supervision, including shotfirers and any contractors involved on the site.

NOTE Paragraphs 319 and 320 of HSE publication L138 [[32](#)] give recommendations on the preparation of a method statement, including its contents.

On sites where Parts 2 and 3 of the CDM Regulations 2015 [[6](#)] apply (see [4.2.1](#)), the method statement should be an integral part of the health and safety plan developed by the principal contractor.

7.2 Preparation

The following points should be factored into the preparation of the method statement:

- a) scope of the operation and objectives;
- b) general philosophy of explosives works and intended outcome;
- c) technical information;
- d) risk assessment factors (see [Clause 6](#));
- e) details of key personnel, including explosives engineers, shotfirers, explosives storekeepers, and other persons authorized to handle explosives;
- f) an organization chart showing the relationship between the key personnel;
- g) plant to be employed;
- h) services, buildings and structures identified as potentially at risk from blasting operations;
- i) factors to be considered in the determination of the potential exclusion zone and arrangements to ensure the protection of site personnel and the public, and the placing of sentries for each blast (see [7.4.2.4](#));
- j) arrangements for evacuation of personnel, third parties, members of the public, pets, livestock, etc., from the exclusion zone;
- k) system of audible and visible signals giving clear warning of impending blast, actual blast event and all clear, including personnel responsible for giving warnings (see [7.4](#));

- l) the arrangements to be made for the acquisition, storage (if required), transportation and, if necessary, disposal of explosives to comply with current legislation and regulations (see [Clause 9](#));
- m) the arrangements and timing of suitable trial blasts to confirm the way in which the target will respond to the blasting regime being considered;
- n) provision for the preparation of a blast plan for each blast to be carried out, made up of a charging plan and (where applicable) a drilling pattern;

NOTE A number of typical blast plans might be required to indicate to what extent different situations will affect the blast design and execution.

- o) type and position of any containment measures to prevent projectiles;
- p) the positioning and recording of environmental impact measurements, for example, ground vibration and air overpressure;
- q) the method of recording the information in a) to p) and the list of records needed for legal and management purposes;
- r) where applicable, a programme of blasting operations;
- s) procedures for rectifying misfires;
- t) contingency planning for an emergency or an unforeseen occurrence arising during the operation, including the names and telephone numbers of the emergency services or others to be contacted.

The method statement should be signed off by an explosives engineer other than the person who prepared the method statement, and preferably one employed by the client.

7.3 Implementation of the method statement

Prior to finalizing the method statement, the shotfirer and the explosives engineer should be aware of the requirements imposed by all the relevant documentation pertaining to the blasting operation.

Changes by the explosives engineer on site to the method statement should be independently reviewed and agreed and recorded preferably before any explosives are delivered to the blast site.

Where amendments are made to the method statement, the explosives engineer should ensure that the amended version is passed to every person who was in receipt of the original in time for their consideration before the operation continues.

Any variations in the method statement made during charging should be subject to change management procedures (see [5.2.5](#)) and be recorded in detail.

NOTE It is assumed that, when the blast is planned, all other procedures and practices recommended in this British Standard have been followed up to the stage of the explosives being available at the blast site and ready for charging.

Any changes to the blast plan that become apparent prior to charging should be agreed by the person responsible for approving the original design.

Charging should not commence until the shotfirer has checked that all shot holes drilled conform to the blast plan. Where they do not conform, they should be re-drilled or permission obtained from the designer of the blast plan to amend the plan, unless the method statement empowers the shotfirer to make variations to the plan.

The shotfirer should ensure that each shot hole is charged in accordance with the method statement, and that detonators, explosives and stemming are positioned in their correct location in the shot hole.

Where the shotfirer is unable to comply with the method statement or when the exclusion zone appears to be different from that shown in the method statement, operations should be suspended until the differences have been resolved and independently reviewed. Revisions to the method statement should be reviewed by an independent explosives engineer, unless the variations are of such a nature and extent as to be within the limits of the shotfirer's discretion as set out by the explosives engineer in the method statement.

Detonators should not normally be inserted into explosives until the charges are about to be finally placed. If charges are made up in advance, a safe system of work for prior priming and transport should be implemented.

Where, because of conditions at the charging place, the explosives engineer considers that prior priming would be a safer option, a pre-agreed method statement should be implemented for the construction of a suitable priming station and for the transport of primed explosives to the blast site. The method statement should extend to include the adjacent operations and equipment that might affect the safety of the priming and transport of the primed explosives.

7.4 Exclusion zone and warning procedures/systems

7.4.1 Positioning of shotfirer/explosives engineer

The person firing the shot should be positioned outside the blast zone, but may exceptionally remain within the exclusion zone if protected by a shotfiring shelter positioned and constructed in accordance with the Mineral Products Association guidance, *Positioning a shotfiring shelter* [N4] (see also [12.7.4](#)) or place of equivalent safety.

7.4.2 Blast warning procedures

7.4.2.1 General

Before any blasting commences on a construction site a suitable system of signs, signals and sentries should be established which uses fit for purpose systems, including audible and visual signalling systems where appropriate, to give warning of blasting operations. The code of signals to be used should be notified to all personnel involved in securing the zone and others affected by the event, including the general public. The explosives engineer should ensure that the system is practised before the event.

7.4.2.2 Audible warning systems

An audible warning system should be established to signify to all persons that they withdraw from the exclusion zone. The warning should comprise a series of readily recognizable and identifiably different signals such as a hooter or whistle with a distinctive tone.

No persons should return to any location within the exclusion zone until the "all clear" signal has been given.

The code of signals may be varied to suit site conditions, but once established for a particular site should not be altered without good reason and adequate communication to all personnel.

7.4.2.3 Visual warning systems

Large, clear notices should be posted on all access roads to the site and located safely outside the exclusion zone.

NOTE 1 The notices are required to conform to the Health and Safety (Safety Signs and Signals) Regulations 1996 [13].

Measures should be put in place to warn personnel who might fail to hear warning signals because of noisy machinery or other diversions during blasting.

Where control of public access to the site is difficult, additional visual signals, such as red flag(s), should be displayed in prominent positions so that they are visible over a wide area when blasting is in progress, e.g. on a tower, flag pole or high fence.

7.4.2.4 Sentries

At blasting times sentries should be positioned as planned and in accordance with the agreed method statement, and should be posted at the accesses, with clear instructions as to when they have to stop access to the site and when they can allow access. Where a public road passes close to the site, so that there is a danger to traffic from either projected material or distraction to drivers, the assistance of the police should be obtained in controlling traffic. Where road closures or diversions are required, permissions should be obtained in accordance with the local highway department authority.

The sentries should be in communication with the shotfirer, either directly or indirectly. Where standard electric detonators are used, a suitable means of communication should be introduced to prevent premature initiation.

NOTE This may be by radio communication using hand-held radios, provided they are not taken within 10 m of a circuit containing standard electric detonators and are switched off at the firing point, or preferably not taken within 5 m of the firing point.

Where control of site personnel is complicated by the presence of different contractors and progression of different jobs on the site, special shotfiring shelters with sentries should be provided. Each sentry should check that all working groups and individuals under their control have retired to the shelter before blasting begins. A detailed system should be in place to ensure that all parties on site have a coordinated procedure for withdrawing from the exclusion zone and recording the location of all personnel.

8 Supervision and responsibility

- 8.1 Only persons who are able to demonstrate that they are suitably trained, experienced and competent should handle explosives, design blasts, or approve blasting procedures.
- 8.2 For blasting operations on a construction site there should be an explosives engineer with overall responsibility for the acquisition, storage, handling, transport and use of all explosives, detonators and accessories, and a clear statement in writing of their duties and responsibilities. Shotfirers or other persons who are to assist the explosives engineer in performing these duties should also be authorized in writing to do so.
- 8.3 No person other than those designated in 8.2 should be in possession of explosives on site.
- 8.4 Competence in explosives engineering involves the successful completion of a course of training (including continuing professional development), which should include:
 - a) shotfiring (see [Annex A](#)); and
 - b) possession of a QCF/SQCF Level 5 Diploma in Shotfiring Supervision for the Extractive and Minerals Processing Industries (see also [Annex B](#)),together with the accumulation of the relevant practical and theoretical knowledge and experience necessary to carry out the full range of explosives engineering duties, including the supervision of others as appropriate. Membership or Fellowship of the Institute of Explosives Engineers should also be considered as demonstrating competence in explosives engineering (see also [Annex C](#)).
- 8.5 Competence in shotfiring requires successful completion of a course of training (including any refresher course as part of continuing professional development) covering the subjects referenced in [A.2](#), and evidence of sufficient knowledge and experience for the performance of the full range of shotfiring operations.

- 8.6** When one or more contractors are involved in work on the same site, the principal contractor should ensure close liaison and collaboration with the explosives engineer and/or the shotfirer responsible for the explosives work, both in the planning and in the execution of the work, so as to prevent any hazard to personnel, materials or equipment. All site personnel present during blasting operations should be under the control of the explosives engineer and/or shotfirer.
- 8.7** During the design, preparation and execution stages of events where explosives are used, a site and task-specific quality assurance and auditing system should be implemented. The mechanics of the system should be proportionate to and suitable for the complexity of the event, and should extend to include all elements of the explosives operations, e.g. pre-weakening, charging, initiation systems, protection, public safety. The system should incorporate documented procedures for addressing areas of nonconformity, remedial actions and re-evaluation of methodology.

9 Safety and security of explosives during acquisition, transport and storage on site

9.1 General

COMMENTARY ON 9.1

The Explosives Regulations 2014 [8] require that those acquiring and/or keeping certain explosives obtain an “acquire only” certificate from the police for the area where the applicant resides and/or an “acquire and keep” certificate from the police for the area where the store is located.

Transfer of explosives is also covered by the Explosives Regulations 2014 [8] in terms of the requirements to record transactions. Possession of a recipient competent authority (RCA) document is required for civil explosives under the Regulations. However, any physical transport of explosives is required to conform to the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 [18] which implement the European Agreement concerning the International Carriage of Dangerous Goods by Road 2017 (ADR) [5].

In Great Britain, the Explosives Regulations 2014 [8] require possession of a licence in order to store explosives, other than exempted quantities, and compliance with the conditions of that licence. Before certain explosives can be acquired it is necessary to obtain a certificate from the police which certifies that a person is fit to acquire or keep explosives in accordance with the terms of the explosives certificate. Without a certificate it is not possible to acquire relevant explosives from a manufacturer or supplier. In addition, the certificate holder for an explosive for civil use is required to have an RCA document, unless the explosive is used immediately at the place of manufacture.

The storage of quantities of explosive in excess of 2 000 kg will be subject of a licence issued by the Health and Safety Executive (HSE) or the Office for Nuclear Regulation (ONR).

Storage of quantities of less than 2 000 kg is licensable by the police or, in certain circumstances, the local authority, the ONR or the HSE, e.g. on a new nuclear build site or where Schedule 1 (5) of the Explosives Regulations 2014 [8] applies. Guidance on store construction is given in HSE Approved Code of Practice L151 [N2].

Persons wishing to acquire and/or keep relevant explosives should apply for the necessary certificate and RCA document in sufficient time.

9.2 Planning

The type and quantities of explosives to be used, and the techniques to be applied, should be decided before any action is taken to arrange storage or transport. The best location for any store needed should then be determined in consultation with the relevant licensing authority responsible for those explosives.

NOTE 1 It might not be possible to obtain storage facilities for the required quantity of explosives because of the proximity of structures and services which need to be protected. The licensing authority has no discretion to reduce the safety distances required by the stores under the Explosives Regulations 2014 [8]. In the guidance accompanying the Explosives Regulations [27, 28, 29, 30, 31, N1, N2] there are stringent requirements for the construction of stores to ensure that they are secure.

The explosive liaison officer of the relevant police force should be consulted for detailed advice on the standards of construction required for stores (see also 7.4.1), sources from which stores can be purchased and the method of mounting such stores.

If ammonium nitrate/fuel oil (ANFO) types of explosive (including either bulk emulsion or emulsion ANFO blends prepared on site) are to be used, the Explosives Regulations 2014 [8] should be consulted to determine if specific exemptions from the requirement for a manufacturing licence apply.

In general, the types of explosives used in Great Britain can be stored in the same place, whether they are nitroglycerine-based or trinitrotoluene (TNT)-based explosives, slurry explosives, emulsions or explosives of the ANFO type. Detonating cord may be stored in the same compartment, but the detonators should be stored separately. Explosives should be stored in their original packaging. Most commercially available explosives stores have a separate annex suitable for the storage of detonators, but special conditions apply to explosive devices containing exposed iron or steel to prevent sparking in the explosives store by ferrous objects. Care should be taken to ensure that the explosives store used is licensed to do so and satisfies the conditions of the licence. Where there is any doubt, the explosive liaison officer for the relevant police force should be consulted.

NOTE 2 Site-mixed explosives are made for immediate use and are not generally stored except in exceptional circumstances.

As the techniques to be used and the phasing of work on a site influence both the size of explosives store needed and the transport arrangements necessary, these should be established at the planning stage.

9.3 Storage

COMMENTARY ON 9.3

Safety provisions for the storage of explosives are given in HSE Approved Code of Practice L150 [N1].

9.3.1 Responsibility for storage

The explosives storekeeper or shotfirer should be responsible for the explosives store, for its cleanliness, for the proper rotation of stock, for the keeping of records (see [9.3.4](#)) and for good housekeeping in general.

9.3.2 Handling of explosives

Extreme caution should be exercised during the unloading of explosives. Cases containing explosives should not be roughly handled, slid on ramps or dropped. The explosives should be handled only by the supplier's own operatives, by the shotfirer, or by the explosives storekeeper. Unskilled operatives should be allowed to handle such materials only under the direct supervision of the shotfirer.

During delivery of explosives to, or removal of material from, a store no grit should be allowed to contaminate either the cases or the store (see [9.3.3](#)).

All cases of explosives should be stored flat with their top side uppermost and in such a way as to allow the identifying name of the explosive and its manufacturer and date of manufacture to be clearly visible. Cases of explosive should be stacked such that any pile of boxes is stable and is positioned such as to allow all-round ventilation.

9.3.3 Store cleanliness

The inside of an explosives store should be kept clean and free from dust or grit. Store cleanliness should be considered during the planning stage and the store should, if possible, be located on a concrete hardstanding and orientated so that it is protected from the prevailing wind across the site.

When inside a store, personnel should take suitable precautions as regards footwear (e.g. rubber overshoes) to prevent contamination with grit. Boots or shoes with exposed metal studs, nails or metal protectors should not be worn in an explosives store under any circumstances.

The cleanliness of the explosives store should be made the direct responsibility of the shotfirer or storekeeper (see [9.3.1](#)), though the cleaning may be carried out by someone under the personal supervision of the storekeeper.