HSE

Health & Safety Executive

Explosives Regulations 2014

Guidance on Regulations – Commercial manufacture and storage of explosive articles and substances

First published 2015

This guidance has been developed by a sector working group established under the Explosives Legislative Review (www.hse.gov.uk/explosives/news/explosives-legislative-review.htm). It includes content previously found on HSE's website and in the Approved Code of Practice to the Manufacture and Storage of Explosives Regulations 2005 (L139) which was withdrawn on 1 October 2014.

This guidance is issued by the Health and Safety Executive. Following the guidance is not compulsory, unless specifically stated, and you are free to take other action. But if you do follow the guidance, you will normally be doing enough to comply with the law. Health and safety inspectors seek to secure compliance with the law and may refer to this guidance.

Acknowledgements

HSE would like to thank working groups within the explosives industry for their help in producing this guidance.

Contents

Introduction 5

Who is this publication for? 5
What is this publication about? 5
Other guidance that applies to the commercial manufacture and storage of explosive articles and substances 6
Other legislation that applies to explosives operations 6
Application and scope of the Regulations 6

Explosives for work, personal and recreational use 6
Hazard type 7

Terminology 7

Safety requirements 8

General principles of safety in explosives operations 8
Regulatory framework 8

Fire and explosion measures (Regulation 26) 9

Safety measures 9

Identify safety measures 9
Risk assessment 9

Management arrangements 10
Cross-cutting safety measures 10

Competence 10
Safe systems of work and working practices 11
Housekeeping 11
Mounds, traverses and barriers 11
Stock management 12
Segregating explosives presenting different likelihoods of initiation 12
Segregating explosives operations from other activities 13
Safely transporting explosives on site 13

Preventing fires and explosions 14

General precautions 14
Protecting explosives from sources of ignition 15

Measures to limit the extent of a fire or explosion 21
Protecting people from the effects of fire or explosion 22

Limiting the number of people in explosives areas 22
Engineering controls 23
Provision of personal protective equipment 24
Emergency procedures 24

Separation distances 25

Application 25
Mounds and traverses 25
Application of separation distances and regulation 13(6) 25

Separation distances to ammonium nitrate and ammonium nitrate blasting intermediate..... 25

Discarding, disposal and decontamination 27

Discarding and disposal of explosives 27

Appendix 1 Selection, operation and maintenance of pumps and pumping systems 28
Appendix 2 Storage and handling of ammonium nitrate 30

Location of stores 30
Design and construction of stores 30
Construction of stacks 30
Selecting equipment for use with ammonium nitrate 31
Managing maintenance 31
Controlling incompatibility 31
Managing solidified ammonium nitrate 32
Emergency procedures 32
Further information 33

Glossary 34
References and further reading 39

References 39
Further reading 39

'Golden Rules' 39
Hazard identification and evaluation and the assessment of risk 39
Managing safety 39
Topic-based guidance 40

Further information 43

Introduction

People working in commercial manufacture and storage of explosives articles and substances should use the guidance on safety provisions (L150)[1] as a starting point for organising their safety procedures. This document contains the same headings as L150 where additional information is available, and should be used as a source of supplementary guidance.

Who is this publication for?

1 It is for employers and self-employed people who manufacture and store explosives in a commercial environment (ie people whose trade or employment involves the manufacture and storage of explosives).

2 It may also be relevant to:

- other organisations which manufacture or store explosives such as government departments and academic institutions;
- other dutyholders such as individuals who undertake some of the activities described in this guidance for experimental purposes;
- enforcing authorities such as local authority trading standards officers, the police, fire and rescue services and other emergency services; and
- other government or regulatory agencies and waste disposal operators.

What is this publication about?

3 This publication provides guidance on the safe manufacture and storage of explosives in a commercial environment.

4 For the purposes of this document, the manufacture and storage of explosives covers:

- manufacture and storage of commercial blasting explosives and other civil explosives;
- commercial manufacture and storage of military munitions;
- commercial manufacture and storage of ammunition for small arms, shotgun cartridges and similar articles;
- commercial manufacture of pyrotechnic substances intended for use in pyrotechnic and explosive articles, and any storage of those substances and articles associated with such manufacture;
- commercial manufacture of pyrotechnic articles; and
- breakdown or unmaking of explosives and pyrotechnic articles as part of:
    - quality assurance regimes;
    - ongoing qualification surveillance; and
    - other similar activities.

5 Following this guidance will enable compliance with the safety provisions of the Explosives Regulations 2014 (SI 2014/1638) (ER2014).

6 This document also provides guidance on some wider areas which are relevant to ER2014. These wider areas are included as they help support compliance with the safety provisions of the Regulations.

Throughout this guidance, you will see statements in boxes. The statements identify successful outcomes of the application of appropriate safety measures to explosives operations. Dutyholders can use the statements to challenge themselves on the effectiveness of the safety precautions they have implemented.

Other guidance that applies to the commercial manufacture and storage of explosive articles and substances

7 HSE's guidance on the safety provisions (L150)[1] and security provisions (L151)[2] of the ER2014 are referred to throughout this document. In each case, we have quoted the relevant section heading to make it easier for you to find the information you need.

8 HSE's guidance is supported by other topic-based and sub-sector guidance.

Other legislation that applies to explosives operations

9 There are other general health and safety regulations which apply to explosives operations. This publication gives additional guidance where there are particular issues which need to be considered, for example, in selecting work or personal protective equipment.

10 The Pyrotechnic Articles (Safety) Regulations 2015 (SI 2015/1553) apply to the supply of pyrotechnic articles. These Regulations transpose European Directive 2013/29 on the placing on the market of pyrotechnic articles into UK law. The Regulations deal with the harmonisation of standards and the safety of pyrotechnic articles (including fireworks) placed on the market. They also define:

- those products which are available to the general public and the specific age restrictions on sale; and
- those articles which are only for supply to specialists.

11 Fire safety legislation also applies to explosives operations at sites where explosives are manufactured or stored in a commercial environment.

12 Environmental legislation is likely to apply to explosives operations at sites where explosives are manufactured or stored in a commercial environment (see www.gov.uk/environmental-management).

Application and scope of the Regulations

13 Regulations 2 and 3 of ER2014 identify how the Regulations apply to explosives operations. The section provides information and guidance on how the Regulations apply to the safety of the commercial manufacture and storage of explosives substances and articles.

14 Explosives for work, personal and recreational use

15 ER2014 apply to explosives operations whether they are for work or non-work purposes. They therefore apply to anyone storing or undertaking manufacturing operations on explosives for personal recreational use, and to voluntary clubs or societies storing, processing or manufacturing explosives.

16 In certain circumstances, ER2014 also apply to:

- transport;

- offshore activities; and
- explosives in use.

Hazard type

The role of hazard type

17 Hazard type (HT) is central to both the safety provisions and the licensing elements of the Regulations.

18 Hazard type defines and describes the nature of the hazard arising from an explosive in manufacture and storage conditions.

19 Hazard type represents the potential behaviour of the explosives in the form in which they are manufactured or stored. This means that explosives do not have inherent hazard types that can be automatically ascribed without consideration. For example, the bed depth of loose explosives and the degree of self-confinement can alter hazard type.

20 For ease of reference, the definitions of the hazard types given in regulation 2 of ER2014 and additional explanatory text from L150 are reproduced below.

- *Hazard Type 1: '…an explosive which, as a result of, or as a result of any effect of, the conditions of its storage or process of manufacture, has a mass explosion hazard'* (a mass explosion can be one in which the entire body of explosives explodes as one; where a substantial proportion of the explosives present could explode in such a way that the practical hazard should be assessed by assuming simultaneous explosion of all the explosives present; or one which is associated with a serious blast hazard);
- *Hazard Type 2: '…an explosive which, as a result of, or as a result of any effect of, the conditions of its storage or process of manufacture, has a serious projectile hazard but does not have a mass explosion hazard'* (where a fragment hazard arises solely as a consequence of the store, building or structure in which the explosives are present breaking up, the explosives would normally be treated as Hazard Type 1);
- *Hazard Type 3: '…an explosive which, as a result of, or as a result of any effect of, the conditions of its storage or process of manufacture, has a fire hazard and either a minor blast hazard or a minor projection hazard, or both, but does not have a mass explosion hazard'* (ie those explosives which give rise to considerable radiant heat or which burn to produce a minor blast or projection hazard);
- *Hazard Type 4: '…an explosive which, as a result of, or as a result of any effect of, the conditions of its storage or process of manufacture, has a fire or slight explosion hazard, or both, with only local effect'* (ie those explosives which present only a relatively low explosives hazard in the event of ignition or initiation, where no significant blast or projection of fragments of appreciable size or range is expected).

Terminology

21 Further information on various terms used in the Regulations and in this document can be found in the Glossary.

Safety requirements

Explosives operations are subject to robust controls to maintain safety standards.

General principles of safety in explosives operations

22 High standards of safety need to be in place before explosives operations start, and should remain in place – and be effective – for as long as the explosives operations continue. It is generally difficult or impossible to regain control of an event involving explosives once control has been lost. The effects of an explosive event can often be catastrophic, and can impact those beyond the immediate activity, eg members of the public and the emergency services. The safety provisions of ER2014 provide the regulatory framework for identifying and implementing these standards of safety, and are based on generally recognised principles of safe operation in the sector.

23 Information on the ten general principles underpinning the safety provisions of ER2014 can be found in L150 under 'General principles of safety in explosives operations'.

Regulatory framework

24 The safety provisions in ER2014 are contained within five Regulations

- **Regulation 26** requires anyone manufacturing or storing explosives to take appropriate measures:
    - to prevent fire or explosions;
    - to limit the extent of fire or explosion, including measures to prevent the spreading of fires and the communication of explosions from one location to another; and
    - to protect people from the effects of fire or explosion.
- **Regulation 27** requires people storing explosives to maintain separation distances, identifies the circumstances in which separation distances do not need to be applied, and identifies how separation distances are applied to certain sites which are granted a licence by HSE or the Office for Nuclear Regulation (ONR).
- **Regulation 28** requires anyone discarding or disposing of explosives, or who is decontaminating explosives-contaminated items, to ensure, so far as reasonably practicable, that they are undertaking those activities safely.
- **Regulation 29** prohibits the manufacture and storage and import of pyrotechnics containing sulphur and/or phosphorus mixed with chlorates without the approval of HSE.
- **Regulation 13** relates mainly to the grant of licences, but also includes safety provisions. It allows:
    - HSE and ONR to prescribe separation distances at most of the sites they license as an alternative to the 'fixed rules' approach required by regulation 27.
    - HSE and ONR should prescribe certain activities that will be subject to the provisions of the licence at most of the sites they license, to take account of potential interactions between those activities and the manufacture and/or storage of explosives that takes place at that site; and

- all licensing authorities should reinforce the requirements of regulation 26 as they relate to the sale of pyrotechnic articles at a site which is licensed for the storage of explosives.

Fire and explosion measures (Regulation 26)

During manufacture and storage, appropriate measures are taken to:

- **prevent an unplanned fire or explosion;**
- **limit the extent of fires or explosions;**
- **prevent fires spreading;**
- **stop explosions communicating from one place to another; and**
- **protect people from the effects of a fire or explosion.**

Safety measures

25 The appropriate safety measures will depend on the nature of the operations and the explosives.

Identify safety measures

Safety measures to:

- **prevent unplanned fires and explosion;**
- **prevent the spread of fire and the communication of an explosion; and**
- **protect people from the effects of a fire and explosion**

are identified using a structured approach.

Risk assessment

26 Employers and the self-employed who comply with the risk assessment requirements of:

- the Management of Health and Safety at Work Regulations 1999 (SI 1999/3242) (the Management Regulations);
- the Dangerous Substances and Explosive Atmospheres Regulations 2002 (SI 2002/2776) (DSEAR);
- fire safety legislation; and
- (where appropriate) the Control of Major Accident Hazards Regulations 2015 (SI 2015/483) (COMAH)

will have taken the steps necessary to identify the appropriate measures they are required to take under regulation 26(1) of ER2014.

Management arrangements

Appropriate safety measures are in place. Roles and responsibilities for implementing and maintaining them are specified and understood.

27 Arrangements should be in place to manage explosives operations.

28 Employers and the self-employed will generally identify and implement management arrangements as a consequence of their duties under regulation 5 of the Management Regulations.

29 Employers will also have duties as a responsible person under fire safety legislation.

30 Operators of establishments subject to the COMAH Regulations will also have a duty to manage any explosives operations as part of their safety management system.

Cross-cutting safety measures

Cross-cutting safety measures (ie measures that address more than one duty) are implemented to ensure the safe manufacture and storage of explosives.

31 Some safety measures are particularly important because they reduce the risk of an explosion being initiated, and limit the consequences in the event of an initiation. These safety measures are:

- appropriate training and competence;
- safe systems of work and working practices;
- high standards of housekeeping;
- providing and maintaining appropriate mounds and traverses;
- effective stock management;
- segregating explosives presenting different likelihoods of initiation (or different hazard types);
- segregating explosives operations from other activities; and
- safely handling and transporting explosives on site.

Competence

People manufacturing or storing explosives are competent to carry out activities under normal conditions. They understand the hazards and risks which may arise and the actions to take in abnormal or emergency situations.

32 Competent people understand how a fire and explosion can occur and know what to do to prevent it. They understand how it can be stopped from spreading or communicating to other explosives, and know what to do to protect people, including themselves. Having an appropriate level of competence allows everyone involved in explosives operations, including directors, managers, workers and contactors, to recognise the hazards and risks in operational activities, and then apply the right safety measures to control and manage those hazards and risks.

Safe systems of work and working practices

Explosives operations and activities are carried out to agreed procedures.

33 Procedures should cover the way explosives operations are undertaken. They also include the way other activities are undertaken in explosives areas where these activities could act as a source of ignition for explosives or other flammable materials.

Housekeeping

High standards of housekeeping are maintained to:

- **provide control over sources of initiation;**
- **prevent fires and explosions;**
- **reduce the likelihood of a fire spreading or an explosion communicating; and**
- **reduce the risks of people becoming trapped or harmed if a fire or explosion occurs.**

34 Ingredients with explosive properties, or those which, when mixed with other ingredients in the building, are capable of forming an explosive mixture or compound, should also be removed from the building as soon as the process involving those ingredients is completed.

35 Tools and portable equipment should be readily identifiable as being authorised, and their presence and location should be controlled. Methods for controlling the presence of tools in an explosives area include:

- the use of tool lists;
- the use of shadow boards;
- the inventory numbering of tools and portable equipment; and
- specifying the tools required for the explosives operations in 'bench' or operating instructions.

36 Buildings should be designed so that explosives and other dangerous substances cannot accumulate in nooks and crannies, cavities or hollow sections of either the building or equipment.

37 All materials used in the manufacture of explosives should be stored in a dry location and/or under any other conditions advised by the supplier.

38 Incompatible materials must be kept separately from one another. Suppliers' guidance on the storage of particular materials should be referred to and followed.

Mounds, traverses and barriers

Mounds, traverses and other barriers are used to prevent or limit the spread of fires or the communication of an explosion, and to protect people.

39 Unless explosives are effectively segregated by distance, mounds and/or traverses should be used to protect people, prevent or limit the spread of fire, or the communication of an explosion involving HT1 or HT2 explosives which are being worked on or are in storage.

40 Filled container mounds are often used with smaller stores containing HT1 and HT2 explosives. If a filled container mound is used, it must be of sufficient height and thickness to be effective. The following examples describe container mounds appropriate for use with smaller stores:

- store dimensions 0.91 m x 0.76 m x 0.84 m high containing 75 kg of HT1 explosives: a 1 m thick mound; minimum height – the height of the store;
- store dimensions 1.68 m x 1.68 m x 1.52 m high containing 450 kg of HT1 explosives: minimum thickness 1.2 m; minimum height – the height of the store.

41 These examples assume that the mound is located approximately 1 m from the building's walls, and that the 2 degree and 600 mm rules are met.

42 For larger stores, the size of the mound should be increased appropriately.

43 Doors to storage buildings should be kept closed unless immediate access is required to the buildings' contents.

44 Doors to both stores and process buildings should either be left open when people are present in the building, or fitted with a push-bar that allows people to easily open the door in case of emergencies.

Stock management

Dutyholders know the type and quantity of all explosives present on site and their locations.

45 The effective monitoring of stock levels and locations will be of particular relevance to the measures in place to manage:

- articles and substances which are incompatible with each other; and
- explosives manufactured or acquired for research and development.

Segregating explosives presenting different likelihoods of initiation

Explosives which have significantly different likelihoods of initiation are segregated from one another.

46 Storage buildings should be separated from production buildings and other areas where explosives are worked on. Separation should be sufficient to ensure that an explosion which takes place in a production area (where the risk of an explosion is greatest) does not rapidly propagate to storage buildings (where the greatest amount of explosive substances or articles is kept, and therefore the hazard is greatest).

47 Explosives should not in general be manufactured or processed in storage buildings or storage areas.

48 Where it is necessary to have finished explosives articles in a production area (eg the packing of a selection of components or the use of a finished explosive article as a component part of another explosive), stocks must be planned and managed with the aim of keeping the quantities of explosive in production areas to that needed for the job in hand.

49 Whenever practicable, the quantity of explosives present in the production area should be minimised and risks reduced by:

- keeping articles which are not being worked on in an expense store;

- keeping detonators and other initiating devices necessary for the process in segregated storage until they are required;
- fitting detonators and other initiating devices to explosive articles as late in the manufacturing process as practicable;
- returning packages of explosives to a store when those articles are no longer required for the task at hand; and
- placing articles which have been worked on into appropriate packaging, and then placing those packages in an appropriate store.

50 Explosives should only be removed from their transport packaging in an appropriate place. Normally, this will be in a production building, a picking store, or another place where an event involving the explosives being handled will not communicate directly with the explosives in storage.

51 There may be some circumstances (for example, checking the condition of stocks of explosives, or certain minor maintenance tasks) where it may be necessary to carry out activities within the store to avoid creating additional significant risks by moving explosives out of, and then back into, the store. If it is necessary to carry out activities in a store, the activities should:

- be carefully planned;
- be controlled and supervised;
- be based on a suitable and sufficient risk assessment; and
- where the process introduces a significant risk, the activity should be subject to the use of a permit-to-work system.

52 Damaged or deteriorated explosives, and explosives which are contained within damaged or deteriorated packaging, generally present an enhanced likelihood of initiation. They should be stored in a designated place segregated from other explosives. Where a damaged or deteriorated explosive, or explosives in damaged or deteriorated packaging, have been assessed by a competent person as being safe to store, this segregation can be achieved by storing them in a separate building or, where any event is likely to be contained, in a separate suitable storage cabinet or container.

Segregating explosives operations from other activities

Explosives operations are segregated from activities that do not include explosives.

53 Explosives should not be stored anywhere where, in the event of a fire, the fire could quickly spread from or to any other flammable materials (for example, flammable liquids) or materials that can easily catch fire (for example, bulk quantities of paper, cardboard, surplus wooden pallets, display equipment).

54 Explosives should not be stored with products that might create an additional explosion hazard, including oxidising agents, toxic substances, aerosols and bottled gas canisters.

Safely transporting explosives on site

Particular care is taken when transporting explosives on site, and only appropriate methods are used.

55 Vehicles used for transport of explosives on site should be constructed of materials suitable for the type of explosive being carried to avoid inadvertent contamination or contact between incompatible substances.

56 All movements of explosives around the site should be properly supervised to ensure that:

- vehicles and people carrying explosives can be clearly identified;
- the explosives can be identified as such;
- the explosives are never left unattended;
- explosives are not placed, however briefly, where they could be inadvertently mixed up with other goods, especially flammable products;
- packaging containing explosives is not inadvertently handled by staff unaware of their contents;
- explosives leaving the site are loaded immediately before the vehicle is due to depart; and
- explosives arriving on site are unloaded into safe storage as soon as practicable.

57 Explosives which are to be worked on should be taken directly from the store to either a suitably located expense store or the process area or production building. Explosives which have been worked on should be returned to an appropriate store as soon as practicable. Wherever practicable, explosives which have been picked and are ready for despatch off site should be transferred to a designated area in a store or to a despatch store set aside for that purpose. In addition:

- the quantity in movement at any one time should be kept to the minimum necessary; and
- stock replenishment should be timed to avoid the explosives being in movement for an unnecessarily long period of time.

Preventing fires and explosions

(Regulation 26(1)(a))

Safety measures are in place to prevent the accidental initiation of explosives.

58 Inputs of energy should be kept to the lowest practical levels (for example, using low-pressure pumps when pumping emulsions, or using the lowest suitable pressure when pressing explosives).

59 Similarly, the rate of application of energy should be kept to the lowest practical level (for example, by using the lowest stroke speed practicable when machine pressing explosives).

60 The following sections give guidance on how the main sources of ignition can be controlled and the general principles that can be followed to prevent fire and explosion.

General precautions

Explosives operations only occur in an appropriate place, using appropriate tools and equipment and following an appropriate process.

61 Equipment design and selection should recognise that wear (for example, on seals) may lead to explosives getting into moving parts (such as bearings and motors) or explosives becoming contaminated and therefore being subject to:

- electrical and electrostatic energy;

- mechanical sparks;
- heat and temperature;
- impact and friction;
- pressure; and
- chemically incompatible materials.

62 In some circumstances, the equipment design and selection process may conclude that, because of the properties of the explosives being used in the process, it is safer to design the equipment in such a way as to avoid the need for the fitting of seals.

Protecting explosives from sources of ignition

Explosives are protected from those sources of ignition that could cause them to initiate, and are kept in a suitable closed container or in suitable packaging, whenever it would be reasonably practicable to do so.

63 Transport packages and other packing designed to protect explosives from sources of ignition should not be left opened in storage areas, and should normally only be opened when access to the explosives is needed. After opening, it is important to close the packaging securely to ensure that it does not open inadvertently.

64 Manufacturers often produce a batch of explosive articles by removing a few of each component from boxes held in stock. The outcome is that they will store part-filled and previously opened boxes of explosives. Repeated opening and resealing can result in a box that will not close properly.

65 Where boxes are likely to become damaged because of repeated opening and resealing, alternative methods of resealing the box should be used. These include:

- placing a suitably-sized wooden sheet over the flaps;
- keeping explosives in robust, re-usable, lidded containers made of a suitable plastic or other material;
- keeping part-boxes of compatible explosives in a picking store in, for example:
- open transit cartons which have been covered with a suitably-sized wooden sheet;
- lidded wooden bins; or
- wooden cubby holes; and
- repackaging the explosives in an undamaged box.

Naked lights and flames

Robust systems are in place to prevent the introduction of naked lights and flames into explosives areas.

66 Matches, lighters and smokers' materials should be forbidden from explosives areas or areas where they could result in a fire that could communicate to explosives, unless they are specifically required for the activity being undertaken

67 Wherever practicable, the need for powered vehicles to enter an explosives building should be avoided, for example by using manual pallet trucks for the movement of pallets within explosives buildings.

68 Only battery or diesel-powered vehicles should be used in explosives buildings. Detailed information on the selection of mobile equipment for use in explosives buildings can be found in Section 13 of the CBI-EIG publication *Guidance for electrical installation and equipment within explosives manufacturing and storage facilities including fireworks*[3].

69 Mobile equipment should be fitted with a suitable fire extinguisher for fighting any fire on the vehicle. Such equipment must not be left running while unattended.

Heat and temperature

Potential sources of heat energy and high temperature are identified and kept to the minimum necessary for the safe operation of an explosives area.

70 Ensure that explosives, ingredients and components which are sensitive to heat do not come into unintentional contact with hot surfaces, or exposure to direct sunlight and other strong sources of illumination. Where contact is intentional (for example, during processing or inspection), the temperature and period of exposure must be controlled to prevent unwanted initiation.

71 Where heat is used as part of the process (for example, melting, extrusion at temperature or drying of explosives), the lowest practical temperature should be specified and used. In determining the appropriate temperature, a sufficient margin of safety should be maintained below the auto-ignition temperature of the explosive and also that of any flammable solvents or other volatile materials that may be present. The determination should take into account:

- the potential differential between measured temperature and the actual temperature of the explosive;
- the level of temperature control in the process;
- the potential for uneven delivery of heat in the process;
- the potential for the process to heat up as a consequence of friction, shear heating etc;
- the thermal stability of the explosive;
- the thermal stability of any other ingredients or materials in contact with the explosive; and
- the duration of the process.

72 When heat is used to dry explosives, the depth of the bed must be kept to a minimum and, whenever reasonably practicable, below the critical bed depth.

73 Where the explosive is a mixture, the potential separation of the more volatile components from the mixture and their susceptibility to heat and temperature should be considered and appropriate safety measures put in place. Such substances may pose a much greater risk of accidental ignition than the mixture itself, or may, by their loss, increase the sensitivity of the explosive to other sources of ignition.

74 Process equipment and thermal control systems should, wherever possible, be intrinsically safe (eg, use hot water that cannot exceed 100°C, rather than using steam). Primary temperature controls should be supplemented wherever practicable by a secondary independent control that will prevent an over-temperature should the primary control system fail, and safety-instrumented systems should be installed to an appropriate standard.

75 Condensates and sublimates that arise out of heating explosives should be controlled. The design of process equipment and the safe system of work should consider:

- the potential for the condensation of vapours and sublimates on cooler surfaces in and around the immediate area of the process; and
- the hazards or sources of ignition the condensates or sublimates present.

76 Depending on the properties of the explosives, it may also be necessary to:

- control the temperature and humidity; and
- monitor the chemical and thermal stability

of the explosives during storage and/or processing if the potential for a heat- or temperature-induced initiation is to be controlled.

Electrical, electrostatic and electromagnetic energy

Sources of electrical energy are identified and kept to the minimum necessary for the safe operation of an explosives area.

77 Electrical equipment should be designed and constructed to prevent it becoming a source of ignition for any flammable liquids, dusts, gases and vapours present in a process or during storage that could act as a source of ignition for any explosives present.

78 Electrical equipment used to test explosive articles should not be capable of arming or firing them. Relevant information, such as limiting voltage and current, for both the test equipment and the explosive article should be obtained from the equipment supplier or manufacturer and the explosives supplier or manufacturer. An analysis should be carried out to demonstrate that the likelihood of initiation during testing is as low as reasonably practicable.

79 Testing should be conducted under strictly controlled conditions. Where an assessment of the residual risks associated with the testing activity identify that there is a real risk of injury, personnel should be excluded from areas where testing takes place. They should also be provided with suitable protection that will prevent them from being hurt, should an initiation during the ancillary activities associated with testing occur.

80 Buildings or other areas used for manufacturing or process activities involving explosives should be protected from lightning. Lightning protection will not be required when either:

- effective arrangements are in place for the removal of the explosives to a suitable protected store when there is either a significant risk of a lightning strike or upon the approach of a thunderstorm;
- the consequences for people and property from an explosive event involving the explosives being manufactured or processed would be negligible; or
- the potential for the communication of an explosive event or fire involving the explosives being manufactured or processed would be negligible.

Mechanical sparks

Potential sources of mechanical sparks, including those that could arise from equipment failure, are identified and kept to the minimum necessary for the safe operation of an explosives area.

81 Where clearances are relied on to prevent ferrous-metal-to-ferrous-metal contact (or contacts with other hard materials that could generate sparks), appropriate measures should be taken to

prevent the accidental introduction of ferrous metal and other hard objects into the process equipment. The appropriate measures include:

- locking, fastening or otherwise securing nuts and bolts in place; and
- screening explosives and other materials used in the process for metallic or other dense objects by, for example:
  - visual checking;
  - sieving; and
  - the use of induction loop or X-ray equipment.

82 Where sieves are used to prevent the introduction of metal and other hard objects into a process, any sieve showing any sign of damage to the mesh should be taken out of use immediately, and recently sieved material carefully checked for foreign bodies if any part of the damaged sieve mesh is missing.

83 The inspection and maintenance arrangements for any machinery where clearances are relied upon to prevent ferrous-metal-to-ferrous-metal contact, or contact between metal surfaces and hard objects (for example, mechanical mixers), should include the checking of clearances and immediate restoration of the correct clearances.

Impact and friction

Potential sources of impact and friction are identified and kept to the minimum necessary for the safe operation of an explosives area.

84 Where impact or friction-sensitive explosives are manufactured, stored or handled:

- work processes should be designed to avoid unnecessary nipping, rubbing and squeezing;
- the quantity of sensitive explosives present should be reduced to the minimum necessary;
- the height at which explosives are handled or stored should be minimised to reduce the force of any impact should they be dropped;
- workspaces, walkways and passageways should be laid out to reduce the risk of objects being dropped on, or knocked into, explosives;
- special soft-floor surfaces (for example, bitumen or lead) should be used in areas where explosives may be handled (the electrostatic precautions required for the application need to be considered when selecting the floor-surface material); and
- soft overshoes should be worn where the explosives are very sensitive to impact or friction.

85 Explosives which are sensitive to impact or friction should be protected from the introduction of foreign objects into process machinery. The safety measures taken to protect such explosives should include:

- ensuring equipment is cleaned after use;
- ensuring sufficient clearances between moving parts, both at the designed operating temperatures and at foreseeable departures from those temperatures (the clearances for use in explosives manufacture may need to be greater than for other operations);

- securing screws and other mechanical parts with wires or locking compound to prevent them from falling from the equipment into the explosives during manufacture;

- taking steps to prevent personal protective equipment or ancillary items (for example, valve keys and scoops) falling into the explosive during manufacture; and

- preventing the introduction of foreign objects into moving machinery.

86 Where clearances are relied on to control sources of ignition arising from impacts or friction, the planned preventative maintenance/inspection schedule should include the checking of clearances and their immediate restoration, where necessary. There should be no cracks or holes where material might accumulate and be confined; for example, all welds should be continuous and flush, and blind-threaded holes should be avoided where practicable.

87 Where sieves, filters and screens are used to prevent the introduction of metal and other hard or foreign objects that could act as a source of ignition into a process, the guidance at paragraphs 109-111 should be followed. Sieves, filters and screens should be designed to stop foreign bodies while allowing process materials to pass freely.

88 The design and selection of materials for hinges and lids of process equipment should minimise the risk of friction and impact during opening and closing.

89 Systems to prevent grit, dirt and foreign matter being carried on shoes into explosives buildings and areas should be used where such contamination is likely to increase the likelihood of accidental initiation. The traditional system involves the use of 'clean boundaries' beyond which outdoor or dirty shoes should not be worn unless contained in a suitable overshoe or boot. The overshoe or boot should not be placed outside the clean boundary.

90 Systems should be in place to sweep floors and dispose of sweepings to prevent the uncontrolled build-up of waste explosives that could become sensitised by grit or other contamination.

91 Waste and contaminated materials that could act as a source of ignition, including by impact or friction, should not be allowed to accumulate in process or storage areas.

Pressure

Sources of pressure are identified and kept to the minimum necessary for the safe operation of an explosives area.

92 Explosives should not be stored or processed in such a way that self-confinement increases the hazard they present unless suitable mitigatory measures have been identified and implemented (eg by safely venting or containing the effects of an initiation in a propellant feed tube, undertaking the activity remotely, or appropriately segregating the activity).

93 Explosion relief should be fitted where extraction systems are used to prevent the build-up of flammable gases, vapours and dusts. Such systems should be designed to allow easy access to collection traps.

94 Energy input should be kept to the lowest practical levels when explosives are subject to pressure as part of a manufacturing or processing operation (for example, using low-pressure pumps when pumping emulsions, or using the lowest pressure possible when pressing explosives).

95 Both the safe maximum pressure and the safe rate of application of pressure must be considered. When determining the safe maximum pressure, the lowest practical pressure should be used relative to the strength of design of the process equipment and the potential outcomes of any explosive event. The safe maximum pressure should include an adequate margin of safety.

96 The determination of the safe rate of application of pressure to explosives should consider:

- the friction and impact sensitiveness of the explosive;

- the potential for adiabatic heating of the explosive (for example, as a consequence of the presence of air pockets in extrusion feedstock); and

- inertia within the system (for example, at the start of an extrusion cycle).

97 When explosives slurries and explosives in suspension are being pumped, a minimum safe pressure (for example, a minimum pump pressure) to prevent settling or separation of slurries should be identified.

98 The application of pressure to explosive mixtures which are solid solutions (for example, nitrocellulose/nitroglycerine-based propellants) can reduce the solubility of one or more of the elements of the solution. This may result in the presence of substances which are more friction- and/or impact-sensitive than the mixture. Pressures that can result in friction- or impact-sensitive explosives should not be applied unless additional safety measures are in place to control those sources of initiation.

99 Process equipment used to handle materials at elevated, reduced or otherwise specified pressures should include a control system designed to prevent the specified limits for the process being exceeded (with an adequate margin of safety).

100 Appendix 1 contains additional guidance on the issues considered in the design, selection, operation and maintenance of pumps and pumping systems.

Chemical incompatibility

Chemicals and materials incompatible with the explosives used or with each other are identified and either kept to the minimum necessary for the safe operation of the explosives facility, or completely segregated from the explosives.

101 Explosives should be stored and processed separately from incompatible materials.

102 Explosives should only be brought into contact with incompatible substances when it is necessary to do so. The conditions for safely mixing explosives with incompatible materials should be known and controlled.

103 The nature of any incompatibilities will depend on the chemical interactions between different materials, but in general, explosives and propellants are often found to be incompatible with such substances as acids, alkalis, strong oxidising or reducing agents, sulphur, phosphorus and strong amines. Water and moisture can be incompatible with some of the ingredients of explosives and can affect the sensitivity of explosives.

104 Materials intended for use in the construction of an explosive article, process equipment or in packaging likely to be in contact with explosives or propellants can also exhibit chemical incompatibility with the explosives they are in contact with or contain.

105 Steps to prevent accidental contact between incompatible materials should be taken, and should include:

- quality control systems aimed at detecting the presence of contaminants in materials, substances etc;

- precautions to keep explosives dry where they are sensitive to water or moisture;

- compatibility testing of all new materials that come into contact with explosives before they are used;

- cleaning tools between jobs to ensure that incompatible explosives or other materials on tools are not transferred from one activity to another;

- ensuring construction materials are compatible with the explosives present in the building to prevent unwanted chemical reactions (for example, rusty iron coming into contact with aluminium and causing a thermite reaction);

- designing and constructing drainage systems so that incompatible substances do not come into contact (either because waste products flow into a common drainage system or because the substance is incompatible with the material used in the pipework); and

- ensuring that solid waste does not enter the main drainage system, and that waste materials in traps and collection devices can be removed easily. Drains or sumps should not be located under structures or process equipment. Drainage systems should also allow access for maintenance.

106 Compatibility between materials should be assessed by appropriate testing, including:

- thermal stability tests;

- vacuum stability tests; and

- contact tests

conducted to recognised standards.

107 Indicators of chemical incompatibility can include colour change, or gas, smoke or heat evolution.

108 Explosions have been caused when substances with similar names but different chemical properties have been confused and mixed with incompatible materials. Where substances have similar names but differing chemical properties (eg sodium nitrite and sodium nitrate, or chlorates and perchlorates), the substances should be kept well apart. Additional measures that allow the different materials to be identified one from the other, such as the use of colour-coded packaging and warning signs, should also be taken.

109 Aluminium and other metal powders are used in a wide range of applications in the manufacture of explosives. Aluminium and other metal powders can be incompatible with a range of materials including, in certain circumstances, water. Even minor water ingress can lead to dangerous levels of hydrogen being produced, which may explode and release aluminium or other explosible metal dusts.

110 Ammonium nitrate is an oxidising agent with a wide range of uses in explosives manufacture. It is chemically incompatible with a range of materials and can behave as an energetic substance. Detailed guidance on the storage and handling of ammonium nitrate can be found in Appendix 2.

111 The inherent properties of the materials and their potential interaction with the explosives being manufactured should be determined as part of the design process and before the equipment is used.

Measures to limit the extent of a fire or explosion

(Regulation 26(1)(b))

Appropriate steps are taken to:

- **limit the size of any explosion or fire that may occur;**

- **stop fires spreading; and**

- **limit the size of an explosive event and the area the event affects.**

112 An incident involving explosives will generally have the potential to cover a large area and communicate very quickly as burning projectiles are thrown around. This means that explosives should:

- only be worked on in the quantities necessary for the task at hand; and
- be kept in a storage area or worked on in a place used exclusively for that purpose.

113 Where very small quantities of explosives are being processed or manufactured, steps should be taken to completely contain the effects of a fire or explosion within the work area, machine etc. Examples of activities where it should be practicable to contain the effects of a fire or explosion include the manufacture of:

- small high-explosive caps;
- small arms ammunition;
- some pressing of small pyrotechnic articles; and
- detonators.

114 Where larger quantities of explosives are involved, it may not be practicable to contain the effects to the immediate work area. In such cases, the building itself and the areas around it should be designed and constructed to control the direction of blast, flame, debris away from people, other buildings, roads etc.

115 Workplaces and work stations should be designed to prevent the propagation of fire and explosion from explosives located in one area to those in another. Where appropriate, this may, for example, include the use of 'airlocks', detonation traps, drenching systems etc.

Protecting people from the effects of fire or explosion

(Regulation 26(1)(c))

Measures are in place to protect people in the event of a fire or explosion.

Limiting the number of people in explosives areas

The number of people in explosives areas is kept to the minimum needed to safely carry out and support the explosives operations.

116 Signs stating who may or may not enter should be posted in low-risk areas, and physical barriers and surveillance systems to control entry should be used in higher-risk areas. Where barriers are used, they should be interlocked to prevent people being present when the process is in operation.

117 Workers who are involved in supporting an explosives operation should not be present in an explosives area where the work they are to carry out can be undertaken efficiently, effectively and safely elsewhere.

118 Further information on limiting the exposure of contractors to explosives activities can be found in chapter 18 of JSP 482[4].

Engineering controls

Engineering controls to protect people from the effects of a fire or explosion are identified on a case-by-case basis.

119 Where very small quantities of explosives are being processed or manufactured, steps should be taken to completely contain the effects of a fire or explosion within the work area, machine etc. Examples of activities where it should be practicable to contain the effects of a fire or explosion can be found in paragraph 113.

120 The protection measures required will depend on the likelihood of an initiation and the potential for the initiation to harm people. Where it is foreseeable that an initiation may occur:

- remote working should be undertaken in cases where the risk of serious injury or death is significant; and
- safety screens and personal protective equipment should be used in cases where the risk of serious injury is low.

121 Operators handling explosive substances or articles should be protected. Protection of hands and eyes is particularly important. The effectiveness of any protective equipment should be assessed. Where appropriate models or historical data are not available, this should be done by type-testing, ie by deliberately and safely initiating the substance or article and observing the potential for harm and the effectiveness of the protective equipment.

Remote operations

122 Certain explosives, propellants and pyrotechnics manufacturing processes carry such a serious risk of fire and/or explosion that, even though the likelihood of initiation has been reduced as low as reasonably practicable, the risk of injury to an operative is higher than the tolerable level of risk. Such operations should be carried out remotely.

123 Remote operations should also be implemented where the type of explosive, sensitivity and likelihood of ignition, nature of the process (including confinement) and the quantities involved indicate that operators would be at significant risk of personal injury, ie where the assessment of an operation shows both the potential to kill or seriously injure, and significant likelihood of initiation.

124 Explosives processes for which remote operations should be considered include:

- the manufacture of primary explosives;
- incorporation of pyrotechnic compositions;
- mixing and handling of propellants and blasting explosives;
- filling warheads for medium- and large-calibre ammunition;
- making detonators;
- propellant extrusion/pressing; and
- pressing and subsequent handling of MTV flare compositions.

125 Each stage of a process should be considered and take account of the hazards/sensitiveness of the raw materials, intermediates and finished product, as well as the effects of elevated temperature, pressure, or increased confinement. In some cases, it may be necessary to carry out tests and trials to gain the information needed.

126 Safeguards should be put in place to prevent access to the remote process area during manufacture, and physical barriers should be used for this purpose. Entrances to manufacturing areas should be interlocked to the process, and the safety measures should be arranged to either isolate positively the power supply or control to the manufacturing unit if any of the entrances are open.

127 Where the process needs to be observed to ensure the safety of anyone entering the explosives area, remote surveillance measures should be implemented.

Safety screens and guarded tools

128 Where there is a foreseeable likelihood of initiation during low-hazard operations, safety screens should be used to protect the operator.

129 Safety screens should either be transparent to allow the operator to observe the operation process, or supplemented by closed-circuit video or mirrors. Consequential risks such as the accumulation of static electricity on a safety screen should be controlled.

130 Shielding arrangements should be firmly anchored, and provide protection to people who are nearby. It may be necessary to perform type-tests on the substances or articles being handled in conjunction with the proposed screen arrangement. Where an appropriate model or historical data is not available, the effectiveness of safety screens should be checked by type-testing.

131 Where a safety screen is used but the hands and arms are likely to remain vulnerable, the screen should be used in conjunction with other equipment such as:

- hand and wrist protection; and
- guarded tools.

132 Guarded tools such as kit-sticks, guarded tweezers, pneumatic or suction devices that separate the hand from the explosive should be used whenever practicable.

Design of nearby buildings

133 Occupied buildings on an explosives site (including control rooms for remote operations) should be constructed in such a way that they provide a reasonable level of protection to people inside from the effects of an explosion in the vicinity.

Provision of personal protective equipment

Personal protective equipment is used as a last line of protection. It is not solely relied on when people can be protected by engineering controls.

134 Recommended industry practice is that people working in the commercial manufacture and storage of explosives subsector should as a minimum wear fire-retardant outer clothing, eye protection, and substantial closed footwear when they are working with explosives or in an explosives building. Where people face a significant risk of burns, they should wear suitable fire-resistant protective clothing, including gloves, which may need to be of a higher specification.

Emergency procedures

Effective emergency procedures are in place.

135 Explosives should not be kept anywhere where, in the event of a fire, they might endanger those using the exits from a building or other place where explosives are being manufactured or processed.

Separation distances

(Regulations 27 and 13(6))

Separation distances are met.

Application

136 The safety distances required to be maintained by regulation 27 and any licence must be complied with.

Mounds and traverses

137 Schedule 5 to ER2014 uses the terms ‘mounded’ and ‘unmounded’ stores. It also defines ‘mounded’ as meaning surrounded by suitable mounds.

Application of separation distances and regulation 13(6)

138 When it grants licences, HSE would normally follow the distances given in the tables in Schedule 5 of ER2014. Alternatively, HSE and ONR may:

- use appropriate formulae to calculate separation distances;
- interpolate appropriate values from the tables;
- apply recognised models, including Chapter 10 of JSP 482; or
- accept a technical justification for the application of shorter separation distances.

139 HSE and ONR would normally follow the same approach to the aggregation hazard types and quantities of explosives required by Schedule 5. HSE or ONR may, however, follow an alternative approach where it has been shown to provide an appropriate level of safety.

Separation distances to ammonium nitrate and ammonium nitrate blasting intermediate

140 Table 1 shows separation distances that HSE and ONR would normally apply between stores holding explosives and stores of ammonium nitrate and/or ammonium nitrate blasting intermediate. Where the explosive is kept in a mounded store, the ‘barricaded’ distances apply. The barricaded distances also apply where there is a natural or artificial barricade around the ammonium nitrate, or between it and the explosive. Site operators should seek further advice from HSE on the suitability of natural barricades.

Table 1 Separation distances between explosives stores and ammonium nitrate/blasting intermediates

1	2	3	4	5	6
Quantity of explosive (kg)	Distance (in metres) to be maintained between the store and ammonium nitrate passing detonation resistance test or ANBI (barricaded)	Distance (in metres) to be maintained between the store and ammonium nitrate passing the detonation resistance test or ANBI (no barricade)	Distance (in metres) to be maintained where the AN has not passed the detonation resistance test (barricaded)	Distance (in metres) to be maintained where the AN has not passed the detonation resistance test (no barricade)	Minimum thickness of artificial barricade (cm)
Under 50	1	5	3	20	30
50–100	1	7	4	23	30
100–200	1	8	5	29	30
200–500	2	11	7	41	30
500–1000	2	15	9	55	30
1000–2000	3	19	11	68	40
2000–3000	4	21	13	75	40
3000–4000	4	23	14	82	50
4000–5000	4	25	15	89	50
5000–6000	4	26	16	94	50
6000–7000	5	27	16	98	60
7000–8000	5	28	17	102	60
8000–9000	5	29	18	105	60
9000–10 000	5	31	19	111	60
10 000–15 000	6	36	21	128	80
15 000–20 000	7	40	24	144	80
20 000–30 000	8	48	28	168	90
30 000–40 000	9	54	33	195	100
40 000–50 000	10	60	36	216	130
50 000–60 000	11	66	39	234	130
60 000–70 000	12	71	43	258	130
70 000–80 000	13	79	47	283	130
80 000–90 000	15	87	52	314	130
90 000–100 000	16	96	57	342	150
100 000–110 000	17	100	61	363	150
110 000–120 000	18	107	64	384	150
120 000–130 000	19	113	68	405	150

Discarding, disposal and decontamination

(Regulation 28)

Explosives and explosives-contaminated items are disposed of or discarded safely.

Explosives-contaminated items are safely decontaminated.

Discarding and disposal of explosives

Explosives are not discarded as general or household waste.

141 People who manufacture or store explosives in a commercial environment will generally be required to dispose of explosives, either as waste arising from manufacturing or processing activities, or as a consequence of the identification of damaged or deteriorated stock.

Appendix 1 Selection, operation and maintenance of pumps and pumping systems

1 The selection, operation and maintenance of pumps is critical to controlling sources of ignition where pumps are used in explosives manufacture and storage.

2 Pumps and pumping systems should be selected to:

- minimise the potential for, and consequences of, a failure of a pump part;
- minimise the likelihood of a hard object entering the pump;
- ensure that the materials used in the construction of the pump are compatible with the explosives or other materials being pumped;
- prevent continuous friction leading to the heating of a stagnant pocket of explosives or other energetic materials;
- prevent discontinuous feed of explosives or other materials to the pump, leading to the inclusion of air pockets in the feed which could be subject to compression heating; and
- prevent the collapse of a feed hose leading to starvation of the pump.

3 A suitable pump and pumping system should also:

- not subject the explosives or any energetic ingredients to excessive friction or temperature; and
- maintain the explosives below their minimum burning pressure (where relevant).

4 These requirements will need to take account of the operating parameters of the chosen pump – for example, torque and operating temperature and pressure under both normal conditions and likely modes of failure.

5 Pumps should be fitted with safety-instrumented systems, including appropriate pressure and temperature gauges, no-flow meters and associated alarms, trips and cut-outs. Instrumentation should be located at an appropriate position, ie pressure measurement as close as reasonably practicable (taking into account the location of other instrumentation) to the delivery outlet of the pump.

6 The maximum safe operating pressure of the pumping system should be determined and measures put in place to ensure pressure is controlled within specified levels, for example by fitting an appropriately rated bursting disc as near as reasonably practicable to the delivery of the pump to prevent operation outside specified limits.

7 Pumps used for handling explosives or other materials in explosives areas should be protected to prevent them running dry (ie continuing to run when there is no product to pump) or deadhead pumping (ie pumping against a complete blockage). Both events will result in localised heating, which in turn can result in a fire or explosion in the pump. One option is to use diaphragm pumps, which will stall in these situations. Alternatively, trips should be fitted to discontinue pumping automatically if either:

- there is a ‘no-flow’ of product in the pump because of blockage or product starvation; or
- the pump exceeds the design running temperature or maximum running pressure.

8 Safety instrumented systems should comply with a recognised standard.

9 Pumps and pumping systems should be subject to either planned preventative maintenance or risk-based inspection and maintenance.

10 *Guidelines for the pumping of water-based explosives*[5] contains additional information on the selection, operation and maintenance of pumps used in the manufacture and storage of explosives.

Appendix 2 Storage and handling of ammonium nitrate

Location of stores

1 Stores containing ammonium nitrate should be separated from explosives by the relevant separation distances referred to in paragraph 140 and Table 1 in this guidance.

2 Unless there is a fire-resisting barrier between them, a fire-break separation distance of at least 10m should be maintained between ammonium nitrate stores and other buildings or stocks of flammable materials on or off the site.

Design and construction of stores

3 Buildings used for the storage of ammonium nitrate should be:

- well ventilated;
- constructed from materials that will not burn, such as concrete, brick or steel; and
- located away from sources of heat, fire or explosion.

4 The choice of construction materials should take account of the corrosive nature of ammonium nitrate.

5 Buildings should be designed and laid out so that ammonium nitrate cannot accumulate in nooks and crannies or cavities either in the store or in equipment.

6 Arrangements should be in place to restrict access to those who need to enter the building.

7 Storage areas should not be constructed with drains, channels or pits where, in the event of fire, molten ammonium nitrate could become confined. Where there are drains, channels or pits in the immediate vicinity of the store, they should be protected so that molten material cannot run into them.

8 Floors should be made of non-combustible material without hollows where molten ammonium nitrate could accumulate in the event of a fire. Floors should be easy to sweep and clean with water. Care must be taken to ensure that ammonium nitrate cannot accumulate in nooks and crannies or cavities either in the store or in equipment.

9 Light fittings should be robust, made of material which does not readily burn, and constructed or positioned so that ammonium nitrate dust cannot penetrate them.

10 Main electrical switches, fuses etc should be located outside the storage area to minimise the risk of fire. Local switches must not be located anywhere where they could lead to a fire in the store or come into contact with stored ammonium nitrate.

Construction of stacks

11 Self-confinement of ammonium nitrate in large stacks can increase the risk of detonation of the whole stack.

12 Stacks of relatively low-density ammonium nitrate (ie below 900 kg/m^3) should be limited to 2 m high and 3 m wide. There should be a separation between stacks of at least:

- 1 m for ammonium nitrate with a density of more than 850 kg/m^3 and less than 900 kg/m^3;

- 7 m for a pyramidal stack of ammonium nitrate with a density of more than 750 kg/m^3 and up to 850 kg/m^3;
- 9 m for other, non-pyramidal stacks of ammonium nitrate with a density of more than 750 kg/m^3 and up to 850 kg/m^3;
- 9 m for a pyramidal stack of ammonium nitrate with a density less than 750 kg/m^3; and
- 16 m for other, non-pyramidal stacks of ammonium nitrate with a density less than 750 kg/m^3.

13 These distances can be reduced if a barrier capable of preventing the initiation of a neighbouring stack of ammonium nitrate is present.

14 The dimensions of stacks can be increased where:

- ammonium nitrate is kept in a purpose-built store; and
- additional safeguards are in place to prevent or minimise the likelihood of an explosive event involving the ammonium nitrate.

The Good practice guide for the safe storage of solid technical grade ammonium nitrate[6] contains additional information on the storage of lower-density ammonium nitrate.

15 There should be a space of at least 1m between stacks and between the stack and the wall, electrical equipment or heating pipes. Where water sprinkler systems have been fitted, there should be sufficient clearance above the top of the stack to allow for the operation of water sprinklers in the event of fire.

16 Stacks of bagged ammonium nitrate should be stable to avoid the bag falling and either injuring people or breaking open and creating a spillage.

Selecting equipment for use with ammonium nitrate

17 The choice of equipment should take account of the corrosive nature of ammonium nitrate.

18 The corrosive or solvent properties of any additives or other ingredients (such as fuel oil) that equipment may be used to handle should also be taken into account.

Managing maintenance

19 Ammonium nitrate storage areas (or other working areas where ammonium nitrate is handled) should be thoroughly cleaned before any maintenance that involves heat such as welding or cutting. Apart from the risk of explosion in confined areas, there is also the risk of toxic fumes being produced.

20 Vehicles used to handle ammonium nitrate should be checked carefully for any fuel, lubricating or hydraulic oil leaks, as these can become mixed with ammonium nitrate on the floor and form substances which are potentially explosive.

21 Vehicle maintenance activities or equipment repair activities which introduce sources of ignition, should not take place within a storage area for ammonium nitrate.

Controlling incompatibility

22 Ammonium nitrate should be stored separately from:

- explosives stores and explosives manufacturing and blasting operations;

- fuels such as:
    - flammable liquids;
    - oils and greases; and
    - powdered metals; and
- incompatible chemicals including acids, chlorates, nitrites, zinc, copper and copper salts.

23 Fuel oil should be stored separately from ammonium nitrate. If stored in the open, the distance between the ammonium nitrate store and fuel must be adequate to prevent cross-contamination. Tanks containing fuel oil should be bunded, with the bund designed to contain 110% of the tank volume.

24 Processes and procedures should be designed to prevent organic material and other foreign materials coming into contact or being mixed with the ammonium nitrate.

25 Vehicles should not be garaged in ammonium nitrate stores. Where vehicles are garaged in the same building as the store, they should be separated from the store by a firewall offering half-hour fire resistance.

26 Walls, floors and equipment should be kept clean, and any spillages should be cleared away promptly. Organic materials such as sawdust should not be used as an aid to cleaning floors, and any contaminated ammonium nitrate should be disposed of promptly.

27 Pallets, ropes or covers should not be allowed to become impregnated with ammonium nitrate.

Managing solidified ammonium nitrate

28 Advice should be obtained from the supplier where ammonium nitrate has caked or solidified.

29 A risk assessment should be performed before any work is carried out on the caked ammonium nitrate. Explosives should never be used to break down a solidified product, as there is considerable risk that the ammonium nitrate will detonate.

Emergency procedures

30 The local fire authority should be informed that ammonium nitrate is being stored. Arrangements should be agreed for giving early warning of a fire, providing suitable access to the site and ensuring that there is an adequate supply of water available to tackle an incident. Additional safeguards may be necessary at some sites which are close to neighbouring buildings. These may include automatic fire detection or a fixed deluge system.

31 Where there are homes or businesses in the immediate area, the emergency plans should include arrangements for alerting and evacuating those off the site who would be at risk in the event of a fire or explosion (including those at risk from toxic fumes). These arrangements should cover periods when the site itself is unattended.

32 Employees should be trained and practised in the actions to take in the event of a fire involving an ammonium nitrate store. This includes deciding whether or not to use portable fire-fighting equipment in the fire's early stages.

33 Employees should receive specific training to ensure they do not put themselves at risk of breathing fumes from decomposing ammonium nitrate. The effects of inhaling these fumes may be delayed, and immediate medical help should be called if fumes are inhaled.

Further information

34 Further information on the safe storage of ammonium nitrate can be found at www.hse.gov.uk/explosives/ammonium.

Glossary

2 degree rule a generally accepted approach to the design of mounds and traverses intended to prevent the sympathetic initiation of explosives elsewhere by high-velocity fragments. The 'rule' requires the subtended angle between a stack of explosives and the top of a mound or traverse to exceed 2 degrees. More information can be found in chapter 7 of JSP 482.

600 mm rule a generally accepted approach to the design of mounds and traverses intended to prevent the sympathetic initiation of explosives elsewhere by high-velocity fragments. The 'rule' requires the top of the mound or traverse to be at least 600 mm above the height of the stack of explosives. More information can be found in chapter 7 of JSP 482.

antistatic regime the arrangements which are in place to limit the accumulation of a static charge and ensure that any discharge of an accumulated charge is safe.

civil explosive an explosive which has been or would be classified in accordance with the UN Recommendations as falling within Class 1 but it does not include:

- ammunition the acquisition of which is regulated or prohibited by virtue of the Firearms Act 1968 to 1997;
- any explosive which it is shown is intended for the lawful use by the armed forces or the police of any country; or
- a pyrotechnic article.

communication the process of an ignition, burn, deflagration, detonation or other explosive event progressing to adjacent or nearby explosives.

competent authority an authority or other body designated as such in member states which are contracting parties to the European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR). A list of competent authorities can be found on the United Nations website (www.unece.org).

conductive regime the arrangements in place to prevent the generation of static electricity and its accumulation.

critical bed depth the minimum depth of a bed of an explosive at which detonation will take place.

cross-cutting safety precaution an appropriate measure that addresses more than one duty.

deflagration exothermic chemical decomposition of a material in which the reaction front advances into the unreacted material at less than the speed of sound.

despatch store a store or area within a store where explosives which have been prepared or packaged for despatch are kept before leaving site. Despatch stores keep explosives which have been worked on or which have been selected from a display separate from other stock. They can reduce the likelihood of an incident communicating when explosives present different likelihoods of initiation, and reduce the likelihood that materials intended for a display become mixed with other stock.

detonation a chemical reaction that progresses through an explosive at a rate exceeding the speed of sound in the reaction zone.

dwelling for the purposes of regulation 27 and Schedule 5, a 'dwelling' includes an individual flat within a block of flats.

expense store generally, a small store containing a limited quantity of explosives awaiting processing located a short distance from where the processing activity will take place. Their smaller holdings of explosives generally mean that separation distance requirements can be met more easily, and the safety and efficiency of processing activities can be improved.

explosion a violent reaction of an explosives substance or article with the potential to cause harm or damage to its surroundings by either shock, overpressure, thermal effects or projected effects and fragments.

explosive includes explosive articles, explosive substances and desensitised explosives. Explosives are defined according to their properties and by the criteria in the United Nations Recommendations on the Transport of Dangerous Goods as revised or reissued from time to time. Pyrotechnic substances are considered to be explosives for the purposes of the Regulations, along with pyrotechnic articles that would, if classified for transport, fall within UN Class 1 or be too dangerous to transport because of their explosive properties. However, this does not mean that a substance or an article has to have been subjected to formal classification procedures before it is considered to be an explosive.

The interpretation of 'explosive' in the Regulations contains an important qualification intended to exempt short-lived, explosive chemical intermediates which are produced but then further chemically modified as part of the same manufacturing process. If the process:

- does not chemically alter the substance so that it can no longer be considered to be an explosive;
- involves the retention of the explosive substance for a significant period of time; or
- involves the isolation of an explosive chemical (including any explosive by-product)

it will be subject to the Regulations even if the explosive is added to a diluting medium to desensitise it.

explosive substance an explosive substance can be a single substance or a mixture of substances:

- the definition of explosive substance excludes gases and mixtures of gases; and
- the explosion effect must be created by a reaction in the substance or preparation in itself (or in the case of a pyrotechnic effect, by a self-sustaining reaction). This does not therefore include a secondary reaction which involves substances or preparations which were not part of the original explosive substance.

explosives area any area, which may be outdoors or within a building, where explosives are stored, manufactured, disposed of or otherwise processed.

explosives building any building in which explosives are stored, manufactured, or otherwise processed.

explosives operations any activity involving explosives which is subject to the requirements of the Regulations. It will include manufacture, storage, disposal, discard and decontamination, and may include explosives processing that does not constitute manufacture and, on certain sites, use.

fire safety legislation the Regulatory Reform (Fire Safety) Order 2005 (SI 2005/1541) and its equivalent in Scotland, the Fire (Scotland) Act 2005 (asp 5) and the legislation made under it.

flammable fines small particles of flammable materials. They are generally much easier to ignite than the bulk material because they have a much higher specific surface area. Flammable fines can be generated when packaging materials such as wood or cardboard are moved into or out of buildings and rub against walls, doors or equipment.

HSE the Health and Safety Executive.

initiation the act of causing an explosive material to ignite, burn, deflagrate, detonate or otherwise explode.

ISO container a steel freight container specially designed to facilitate the transport of goods, designed and constructed to a relevant standard, and used for the storage of explosives.

manufacture the interpretation in the Regulations specifies certain activities which are regarded as manufacture. However, manufacture is not limited to these activities, but would include any activity where the process undertaken changes the nature of the substance or article. This includes processes where explosive substances or explosives are made or assembled, or unmade or disassembled (for example, manufacture of gunpowder, filling or fusing of fireworks, assembling fireworks displays from components, breaking down jet perforating guns, removing fuses from artillery shells and filling shotgun cartridges and other cartridges for small arms).

The activities covered by ER2014 include the manufacture of explosives and intermediate products for on-site mixing and storage.

There are a number of processes which are not considered to be 'manufacture' for the purposes of the Regulations. These can include:

- packing or repacking explosives or explosive articles;
- breaking down explosives stored in bulk into smaller storage containers;
- labelling explosives or explosive articles;
- testing and proofing explosives or explosive articles; and
- using explosive articles as components to make a product which is not classified as an explosive (for example, the preparation of an explosive actuator into a fire drencher system, fitting air bags to vehicles, fitting ejector seats and other pyrotechnic articles to aircraft).

Where these activities alone are undertaken, there is no requirement to hold a licence under regulation 6. However, such activities fall within the scope of the Regulations as a whole, and of the safety requirements set out in regulations 26 to 29.

net mass the terms 'net explosive content' and 'net explosive quantity' are commonly used in the industry to refer to the weight of the explosive contained within an article (ie less packaging, casings etc). Although these terms are commonly understood to refer to mass, there is scope for differing interpretations of 'content' and 'quantity' in that these could be taken to refer to volume. The term 'net mass' is used for the sole reason of avoiding any scope for confusion or misinterpretation.

offshore the belt of sea over which the UK exercises sovereign jurisdiction, and any area designated under:

- section 1(7) of the Continental Shelf Act 1964;
- section 1(5) of the Energy Act 2008; or
- a 'renewable energy zone' designated by section 84(4) of the Energy Act 2004.

ONR the Office for Nuclear Regulation.

person the term 'person' is used in a number of the Regulations. 'Person' can be an individual and it includes a body of persons corporate or unincorporated.

picking store a store where part-boxes of particular products commonly used in processes are kept. Picking stores are generally stores holding smaller quantities of different types of products or components, and limit the hazards associated with picking items that may not be required in units of a complete transit carton.

place of reasonable safety in a non-explosives building, the meaning of 'place of reasonable safety' is the definition in the fire safety legislation guide[7]:

a place within a building or structure where, for a limited period of time, people will have some protection from the effects of fire and smoke. This place, usually a corridor or stairway, will normally

have a minimum of 30-minutes' fire resistance and allow people to continue their escape to a place of total safety.

For buildings containing explosives, it should be either an exit from a building (including its mound, where present) or a place within the building where, for a limited period of time, people will have some protection from the effects of fire, smoke and radiated heat. This place must have suitable fire resistance to allow people to continue their escape to a place of total safety.

place of total safety in a non-explosives building, the meaning of 'place of total safety' is the definition in the fire safety legislation guide[7]:

a place, away from the premises, in which people are at no immediate danger from the effects of the fire.

For buildings containing explosives, in addition to the above, it includes a place away from the building in which people are at no immediate danger from the effects of the fire or potential explosion.

For explosive sites, the place of total safety is not the same as the 'minimum hazard zones' identified within the operational guidance for the fire and rescue service.

propagation the process of burning, deflagration, detonation or other explosive effect progressing through the mass of material in a container or stack.

pyrotechnic articles articles that contain explosives substances or an explosive mixture of substances designed to produce heat, light, sound, gas or smoke or a combination of such effects through self-sustained exothermic chemical reactions. They include fireworks plus other items such as flares, smoke signals and flash cartridges. Pyrotechnic articles will also include:

- all articles described as such by a notified body under the provisions of Directive 2013/29/EU;
- pyrotechnic articles that are equipment falling within the scope of Directive 96/98/EC; and
- percussion caps intended specifically for toys falling within the scope of Council Directive 2009/48/EC

pyrotechnic substance an explosive substance of a kind designed to produce heat, light, sound, gas or smoke, or a combination of any of these, as a result of non-detonative, self-sustaining, exothermic chemical reactions.

reasonably practicable this means balancing the level of risk against the measures needed to control the real risk in terms of money, time or trouble. However, you do not need to take action if it would be grossly disproportionate to the level of risk. See www.hse.gov.uk/risk/expert.htm.

relevant explosive means an explosive for which an 'explosives certificate' is required under regulation 5 of ER2014 for acquiring or keeping that explosive, or would be required if it were not being acquired or kept by a person or organisation exempted by regulation 3(7). In relation to regulations 35 (records) and 37 (reporting loss) of ER2014, it also includes:

- ammunition, the acquisition of which is regulated or prohibited by virtue of the Firearms Act 1968 to 1997; and
- smokeless powder

even though, in the case of smokeless powder, an explosives certificate is not always required for its acquisition or keeping.

Explosives listed in Schedule 2 (other than smokeless powder, as noted above) and pyrotechnic articles (apart from those listed in Schedule 3) are not relevant explosives.

relevant standard a code of practice or other standard linked to legislation (CEN, BS EN, ANSI, BS, IEC, ISO) or a published and commonly known industry-produced standard of performance, providing specific standards relevant to an explosives operation, activity or facility.

A relevant standard will be a document established by consensus and approved by a recognised body which provides for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context.

A relevant standard will be based on consolidated results of science, technology and experience.

separation zone area around a site which falls within a separation distance.

site 'site' is defined as 'the whole area under the control of the same person'. In most instances, it will be the same as the area of the establishment at which the explosives operations take place, although in some cases, the extent of the area under the control of that person will be much greater than the area within which the explosives operations take place. See www.hse.gov.uk for more detailed guidance on the application of the Regulations to sites which are shared by different people, and between a parent company and its subsidiaries (or between subsidiaries).

storage includes all possession, keeping or holding other than when the explosives are actually undergoing manufacture or are in use.

storage area any area where explosives are stored either on a short- or long-term basis.

References and further reading

References

1 *Explosives Regulations 2014. Guidance on Regulations – Safety provisions* L150 HSE Books 2014 ISBN 978 0 7176 6551 8

2 *Explosives Regulations 2014. Guidance on Regulations – Security provisions* L151 HSE Books 2014 ISBN 978 0 7176 6638 6

3 *Guidance for electrical installation and equipment within explosives manufacturing and storage facilities including fireworks* Confederation of British Industry www.eig.org.uk/eig2007/wp-content/uploads/30777%20BAE%20Systems%20CBI%20GuideV2.pdf

4 *Ministry of Defence explosives regulations* JSP 482 MOD 2013 www.gov.uk/government/collections/jsp-482-mod-explosives-regulations?

5 *Guidelines for the pumping of water-based explosives* Natural Resources Canada ISBN 0 660 19110 5 http://publications.gc.ca/site/eng/250650/publication.html

6 *Good practice guide for the safe storage of solid technical grade ammonium nitrate* www.safex-international.org/_index.php

7 *Fire safety legislation guide* www.gov.uk/government/collections/fire-safety-law-and-guidance-documents-for-business

Further reading

'Golden Rules'

Leading members of the explosives sector have produced a set of documents known as the 'Golden Rules'. They describe recommended industry practice for working with explosives, safe conduct in explosive areas and design of explosive facilities. They can be found at www.eig.org.uk/?p=431.

Hazard identification and evaluation and the assessment of risk

General information on risk assessment can be found at www.hse.gov.uk/risk/index.htm

More information describing approaches to the identification and evaluation of explosives hazards and the assessment of risks associated with explosives operations can be found in:

Risk assessment for explosives including fireworks: A practical approach to risk assessment which is relevant to small companies including wholesale and retail organizations involved in the storage, distribution and supply of explosives including fireworks Confederation of British Industry 2012 www.eig.org.uk/eig2007/wp-content/uploads/Guide-on-Risk-Assessment-.pdf

Protective measures: A guide on measures other than personal protective equipment to protect people in explosives working areas Confederation of British Industry 2003 ISBN 0 85201 572 0 www.eig.org.uk/eig2007/wp-content/uploads/PROTECTIVE_MEASURES.pdf

Managing safety

More information on establishing effective management arrangements can be found in the following sources:

See the *Health and safety toolbox* website for more information on multi-occupancy workplaces www.hse.gov.uk/toolbox/index.htm

The *health and safety toolbox*: How to control risks at work HSG268 HSE Books 2014 ISBN 978 0 7176 6587 7 www.hse.gov.uk/pubns/books/hsg268.htm

Managing for health and safety website www.hse.gov.uk/managing/

Managing for health and safety HSG65 (Third edition) HSE Books 2013 ISBN 978 0 7176 6456 6 www.hse.gov.uk/pubns/books/hsg65.htm

Worker involvement

See the *Worker involvement* website for more information on consulting employees www.hse.gov.uk/involvement

Leadership

Leadership is particularly important in organisations which manage major hazards such as explosives. More information on leadership in health and safety can be found at www.hse.gov.uk/leadership

Training and competence

For general advice on health and safety training, see *Health and safety training: A brief guide* Leaflet INDG345(rev1) HSE Books 2012 ISBN 978 0 7176 6466 5 www.hse.gov.uk/pubns/indg345.htm

To find competence-related guidance for a specific industry, task or working environment including National Occupational Standards and Sector Skills Councils, see www.hse.gov.uk/competence/industry-specific-competence.htm

For detailed information on assessing the effectiveness of competence in major hazards industries, see *Inspection of competence management systems at COMAH establishments* (Operational Delivery Guide) COMAH Competent Authority www.hse.gov.uk/comah/guidance/inspection-competence-management-systems.pdf

Controlling maintenance and permits to work

Further information on controlling maintenance activities and permits to work can be found at:

Isolation and permits to work www.hse.gov.uk/safemaintenance/permits.htm

Guidance on permit-to-work systems: *A guide for the petroleum, chemical and allied industries* HSG250 HSE Books 2005 ISBN 978 0 7176 2943 5 www.hse.gov.uk/pubns/books/hsg250.htm

Managing contractors

Using contractors: A brief guide Leaflet INDG368 (rev1) HSE Books 2013 ISBN 978 0 7176 6467 2 www.hse.gov.uk/pubns/indg368.htm

Managing contractors: A guide for employers HSG159 (Second edition) HSE Books 2011 ISBN 978 0 7176 6436 8 www.hse.gov.uk/pubns/books/hsg159.htm

Topic-based guidance

Further information on a wide range of explosives safety-related topics can be found at www.eig.org.uk

Further information on the control of electrical, electrostatic and electromagnetic hazards and the hazards arising out of surface temperatures of equipment can be found in *Guidance for electrical installation and equipment within explosives manufacturing and storage facilities including fireworks* Confederation of British Industry 2009 ISBN 978 0 85201 722 7 www.eig.org.uk/eig2007/wp-content/uploads/30777%20BAE%20Systems%20CBI%20GuideV2.pdf

Information about the location of cellular radio transmitters is available from the Office of Communications (Ofcom) at http://sitefinder.ofcom.org.uk/

Further information on protecting people from the effects of explosive events can be found in:

Protective measures: A guide on measures other than personal protective equipment to protect people in explosives working areas Confederation of British Industry 2003 ISBN 0 85201 572 0 www.eig.org.uk/eig2007/wp-content/uploads/PROTECTIVE_MEASURES.pdf

Requirements for remote explosives manufacturing facilities Confederation of British Industry 2005 www.eig.org.uk

Storage of combustible dusts

Safe handling of combustible dusts: Precautions against explosions HSG103 HSE Books 2003 ISBN 978 0 7176 2726 4 www.hse.gov.uk/pubns/books/hsg103.htm

PPE

For guidance on the effectiveness, selection and use of personal protective equipment for use in explosives operations, see:

Review of standards for thermal protection PPE in the explosives industry 2013 RR1002 HSE Books 2014 www.hse.gov.uk/research/rrhtm/rr1002.htm

Guidance on personal protective equipment (PPE) for explosives operations Confederation of British Industry 2014 www.eig.org.uk/?p=583

Fire safety

Fire safety www.hse.gov.uk/toolbox/fire.htm

Guidance on fire precautions at explosives sites licensed by the Health & Safety Executive: Fire precautions at licensed explosives sites Confederation of British Industry 2013 www.eig.org.uk/eig2007/wp-content/uploads/EIF-Fire-Precautions-Guide-20131.pdf

Planning for emergencies

Emergency procedures www.hse.gov.uk/toolbox/managing/emergency.htm

Dangerous substances and explosive atmospheres: Dangerous Substances and Explosive Atmospheres Regulations 2002. Approved Code of Practice and guidance L138 (Second edition) HSE Books 2013 ISBN 978 0 7176 6616 4 www.hse.gov.uk/pubns/priced/l138.pdf

Emergency planning for major accidents: Control of Major Accident Hazards Regulations 1999 HSG191 HSE Books 1999 ISBN 978 0 7176 1695 4 www.hse.gov.uk/pubns/books/hsg191.htm

Separation distances

For further information on how HSE applies separation distances to the sites it licenses, see:

Use of structural justification to underpin an HSE explosives licence Specialised Industry Report Confederation of British Industry 2011 www.eig.org.uk/eig2007/wp-content/uploads/structuraljustification.pdf

Guidance on occupied buildings on licensed explosives sites Confederation of British Industry 2013 www.eig.org.uk/?p=426

Disposal

Further information on the safe disposal of explosives and explosives-contaminated items can be found in *Guidance for the safe management of the disposal of explosives* Confederation of British Industry 2007 www.eig.org.uk/eig2007/wp-content/uploads/disposal_guide.pdf

Decontamination and vacating an explosives site

Management guidance for the safe decommissioning of explosives sites: A guide to the safe decommissioning of explosives sites, the relevant legislation, and the techniques used for decontamination Confederation of British Industry 2003 www.eig.org.uk/eig2007/wp-content/uploads/disposal_guide.pdf

Further information

For information about health and safety, visit www.hse.gov.uk/. You can view HSE guidance online and order priced publications from the website. HSE priced publications are also available from bookshops.

You can report inconsistencies or inaccuracies in this guidance by sending an email to the Explosives Legislative Review team (ELR@hse.gsi.gov.uk). Reports of inconsistencies or inaccuracies will be considered by the Explosives Industry Forum (webcommunities.hse.gov.uk/connect.ti/explosives/grouphome).

Published by the Health and Safety Executive 4/16