

Explosives Regulations 2014

Guidance on Regulations – Manufacture and storage of ammonium nitrate blasting intermediate

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First published 2015

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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and in the Approved Code of Practice to the Manufacture and Storage of Explosives Regulations 2005 (L139) which was withdrawn on 1 October 2014.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.

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Introduction

Who is this publication for?

- 1 This publication is for employers and self-employed people who manufacture and store ammonium nitrate blasting intermediate (ANBI).
- 2 This publication also contains material that may be relevant to other organisations which manufacture or store ANBI, such as government departments and academic institutions which undertake some of the activities described in this guidance for experimental purposes.
- 3 It also contains material relevant to enforcing authorities such as local authority trading standards officers, the police, fire and rescue services and other emergency services. This publication may also be of interest to other government or regulatory agencies and waste disposal operators.

What is this publication about?

- 4 This publication provides guidance on the safe manufacture and storage of ANBI. It also provides guidance on the safety measures that should be considered when ANBI is manufactured or stored on a site where other explosives are being manufactured or stored.
- 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 ER2014.

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 manufacture and storage of ANBI

- 7 HSE has published detailed guidance on the safety provisions (L150)¹ and security provisions (L151)² of ER2014. The content found in the guidance on the safety provisions (L150) provides the general background to this document.
- 8 This document supplements the guidance in L150 and contains additional guidance for those who require a deeper understanding of the measures required to manufacture or store ANBI safely. L150 and L151 are referred to throughout this guidance. In each case, we have quoted the relevant section heading to make it easier for you to find the information you need.

Other legislation that applies to the manufacture and storage of ANBI

- 9 There are other general health and safety regulations which apply to explosives operations, including the manufacture and storage of ANBI. This publication gives additional guidance where there are particular issues which need to be considered, for example, in selecting work or personal protective equipment, or in vacating an explosives site.

Application and scope of the Regulations

10 Regulations 2 and 3 of ER2014 identify how the Regulations apply to explosives operations, including the manufacture and storage of ANBI. This section provides information and guidance on how the Regulations apply to safety and security.

ANBI as an explosive

11 Regulation 2(2) applies the Regulations to the manufacture and storage of ANBI. This means that the manufacture and storage of ANBI are treated as if they were the manufacture or storage of an explosive. Therefore, the safety and licensing requirements apply.

12 Regulation 2(2) only extends the application of the Regulations to the manufacture and storage of ANBI, and has no bearing on the acquisition and transfer requirements of ER2014 or on the application of either:

- regulations relating to the carriage of dangerous goods; or
- the Control of Major Accident Hazards Regulations 1999.

Explosives for work, personal and recreational use

13 ER2014 applies to explosives operations whether they are for work or non-work purposes. They therefore apply to anyone manufacturing or storing ANBI for personal use.

Transport

14 ER2014 *do apply* to the transport of explosives, including ANBI, on site. This includes movement on public roads between different buildings on the same site.

15 ER2014 *do not apply* to ANBI which is being transported by road, rail, air or water, provided that the ANBI is not kept in one place for longer than 24 hours.

16 Explosives, including ANBI, which are being transported will be treated as being in storage when they are kept, or are to be kept, at one place for more than 24 hours.

17 Dutyholders who keep explosives which are being transported as part of the supply chain should ensure that any explosives whose onward journey cannot take place are stored safely and lawfully.

Application offshore

18 ER2014 (other than regulations 4, 5, 31 and 32) apply to certain activities in the UK territorial sea adjacent to Great Britain (for example, coastal construction activities which extend into the territorial sea and the construction, operation and demolition of wind farms).

19 It is currently not expected that manufacture and storage of ANBI will take place offshore. However, detailed guidance can be found in the 'Application offshore' section of L150.

Explosives in use

20 The safety provisions of ER2014 do not generally apply to explosives which are in use. However, the nature of some activities on HSE and Office for Nuclear Regulation (ONR)-licensed sites means there may be constraints on these activities in the licence where they interact with explosives, including ANBI, which are being manufactured or stored.

Hazard type

21 ANBI is not normally considered in terms of hazard type (HT) for the purposes of the Regulations.

Terminology

22 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

23 High standards of safety need to be in place before explosives operations, including the manufacture and storage of ANBI, start, and should remain in place – and be effective – for as long as the explosive operations continue. It can be difficult to regain control of an event involving ANBI once control has been lost. The effects of a fire or an explosive event can 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.

24 There are ten general principles underpinning the safety provisions of ER2014. These principles should form part of the arrangements and working practices of anyone manufacturing or storing ANBI.

- People manufacturing or storing ANBI should be competent to carry out their particular roles.
- The particular hazards associated with the ANBI formulation should be understood.
- The sources of energy that could cause the ANBI to initiate should be identified.
- Appropriate safety measures should be part of a planned and proportionate system of work to control all sources of energy that could cause an initiation.
- Particular care should be taken where an activity involves the application of energy to ANBI to ensure that this is controlled.
- So far as reasonably practicable, the quantity of ANBI being manufactured, stored or handled should be the minimum necessary for the safe and efficient conduct of the operation, and the extent and duration of exposure to the hazard should be minimised.
- The number of people exposed to the hazard should be limited to the minimum necessary for the activity in hand.
- Precautions should be in place to prevent a fire or explosives event from escalating if an initiation does take place.
- Precautions should be in place to protect people if an initiation does occur.
- Robust systems should be implemented to make sure that the necessary precautions are in place and remain effective.

Regulatory framework

25 The safety provisions relevant to the Manufacture and Storage of ANBI in ER2014, are contained within four 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 that are granted a licence by HSE or the Office of Nuclear Regulation (ONR). Regulation 27(2)(b)(ii) identifies that ANBI which is being stored under the provisions of a licence granted by HSE or ONR is not subject to this regulation.
- **Regulation 28** requires anyone discarding or disposing of explosives, or who is decontaminating explosive-contaminated items, to ensure, so far as reasonably practicable, that they are undertaking those activities safely.
- **Regulation 13** relates 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; and
 - HSE and ONR to 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.

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

26 The appropriate safety measures will depend on the nature of the activities that take place on site, and whether ANBI is both manufactured and stored, or whether it is simply stored. Regulation 26 requires safety measures to be taken for:

- the prevention of fires and explosions by controlling sources of energy that could initiate a fire or explosion and the circumstances that could bring about an initiation;
- limiting the extent of a fire or explosion. This involves taking steps to prevent fires spreading or explosions communicating, and limiting the amount of explosives involved;
- protecting people in the event of an explosion. This will involve:
 - considering the number of people who might be affected by an explosives event;
 - having emergency procedures in place;
 - taking steps to ensure people can quickly escape in the event of a fire; and
 - making provision to protect them from the effects of a blast or other explosion effect.

27 An unplanned fire or explosion is:

- a fire or explosion on the site that the person manufacturing or storing the explosives does not intend to happen; or
- an intended fire or explosion that exceeds its expected extent or severity, ie was larger or had more extensive effects than were intended.

28 Safety measures must continue to be effective whenever explosives are present. This means that, as part of those measures, anyone manufacturing or storing ANBI will need to understand how their appropriate measures can fail, and have suitable arrangements in place to ensure their preventative and protective measures remain effective.

Identify safety measures

Safety measures to:

- **prevent unplanned fire 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.

29 In order to identify and implement appropriate safety measures, the following should be considered for each stage of the ANBI manufacturing and/or storage operations:

- how a fire and explosion could occur;
- how to prevent it spreading or communicating; and
- how to protect people.

30 Historical information identifies that the likelihood of a catastrophic event involving ANBI is very low when compared to the potential of conventional explosives. The historical information also identifies that the principal explosion hazards associated with ANBI occur because of:

- failure of controls during manufacture, resulting in the production of material that would be a Class 1 explosive;
- failure of controls during manufacture that results in excess pressure or heat being applied to materials in process; or
- the prolonged engulfment by fire of ANBI in storage tanks.

31 These scenarios should be the focus for identifying the safety measures necessary to control the explosives hazards associated with ANBI, and any methodology should consider the potential for the spread of fires from neighbouring properties, especially adjoining buildings.

Risk assessment

32 Employers will generally identify and implement appropriate measures as an outcome of a risk assessment or as part of the implementation of a safety management system.

33 Where the site or the activities undertaken are complex, it may be necessary to conduct a more detailed hazard identification and evaluation in support of the risk assessment. Further information on hazard identification and evaluation and the assessment of explosives risks can be found in Appendix 1 of L150.

34 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.

35 Regulation 3 of the Management Regulations requires all employers and self-employed people to assess the risks to workers and any others who may be affected by their work or business. This is to enable them to identify the sensible and proportionate measures they need to take to control the risks.

36 Regulation 5 of DSEAR requires a risk assessment to be carried out to identify whether dangerous substances are present on site and the risks they present. DSEAR apply to all hazards arising from both the manufacture and storage of explosives and other dangerous substances on site. This includes, for example, substances not in use, or those in storage awaiting use.

37 Regulation 7 of COMAH requires operators to have a safety management system in place that will identify and evaluate major hazards. It also requires the adoption and implementation of procedures for systematically identifying major hazards arising from normal and abnormal operations, and the assessment of their likelihood and severity.

38 Fire safety legislation requires responsible persons to make a suitable and sufficient assessment of the risks to which relevant people are exposed. This is to identify the general fire precautions that need to be taken to comply with the requirements and prohibitions imposed by fire safety legislation.

Management arrangements

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

39 Arrangements should be in place to manage the safe manufacture and storage of ANBI. These arrangements should address the responsibilities for:

- identifying;
- implementing; and
- maintaining

the safety measures.

40 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.

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

42 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.

43 Further information can be found in Appendix 2 of L150

Cross-cutting safety measures

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

44 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 ANBI manufacture and storage from explosives operations;
- segregating ANBI manufacture and storage from other activities; and
- safely handling and transporting ANBI 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.

45 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 or energetic materials and know what to do to protect people, including themselves. Having an appropriate level of competence allows everyone involved in the manufacture and storage of ANBI, 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.

46 The guidance in L150 on establishing and maintaining competence in explosives operations is also applicable to the manufacture and storage of ANBI.

47 In addition to having the competencies necessary to manage the safety risks arising out of the manufacture and storage of ANBI, dutyholders should also be competent to manage any risks arising out of the constituents of ANBI which are hazardous to health. Information on the health hazards of the materials used in the manufacture of ANBI should be obtained from the suppliers, and other information may be found in manufacturers' or suppliers' safety data sheets. Assessments under COSHH should be carried out not only on the materials handled, but also on the products of combustion, especially where these may be present in confined spaces.

Safe systems of work and working practices

Explosives operations and activities are carried out to agreed procedures.

48 Procedures should cover the way explosives operations are undertaken. They should 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.

49 Developing the safety measures for manufacturing and/or storing ANBI will normally include consideration of:

- the activity and where it is to be carried out;
- the sequence of the tasks needed to complete the activity and how they will be done;
- the outcomes of the hazard identification and analysis;

- the skills and competencies required to deal with the hazards;
- the precautions necessary to prevent a fire and explosion; to stop a fire spreading and an explosion communicating; and to protect people from the effects of a fire or explosion;
- recognised and generally accepted safety procedures covering known hazards;
- how the manufacture and/or storage of ANBI will be segregated from other activities, and any controls necessary to maintain that segregation;
- the tools and equipment (including personal protective equipment) to be used; and
- how to minimise both ANBI waste and other waste that could act as a source of ignition for explosives, and how that waste will be managed prior to disposal.

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.**

50 The areas where ANBI is manufactured or stored should be kept clean of:

- any loose ingredients that may have leaked from containers or articles, or which have been generated during a process;
- other waste materials (including any fine flammable particulates); and
- contamination that could act as a source of ignition or initiation.

51 Care should be taken to ensure that:

- ammonium nitrate or ammonium nitrate blasting intermediates cannot accumulate in nooks and crannies or cavities, either in the store or in equipment; and
- ammonium nitrate or ammonium nitrate blasting intermediates cannot accumulate in hollow sections in equipment such as storage tanks.

52 All materials used in the manufacture of ANBI should be stored in a dry location. Ammonium nitrate, fuels and other incompatible materials must be kept separately from one another. Suppliers' guidance on the storage of particular materials should be referred to and followed.

53 Where packaged ammonium nitrate is stored:

- there should be adequate space between each stack of packages to allow for inspection of the material; and
- the packages should not be piled so high as to damage the packages of the lower units.

54 The prill structure of ammonium nitrate can change or break down when ammonium nitrate is cycled through 32 °C. Changes to the prill structure of ammonium nitrate can alter its susceptibility to

detonation. Whenever it would be reasonably practicable to do so, the storage temperature for ammonium nitrate should be kept below 32°C. If ammonium nitrate is cycled through 32°C, the prill structure should be monitored to ensure that its susceptibility to detonation has not increased significantly.

55 Unused pallets and combustible waste materials should be removed from manufacturing areas and stores.

56 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:

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

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.

57 A mound or traverse is a barrier or barricade that will intercept fragments and debris caused by an explosion in a building or store. Doors can also act as an effective barrier to the communication of a minor event.

58 The normal role of a mound at an ANBI manufacturing or storage facility is to protect the ANBI or ammonium nitrate ingredients from the effects of an explosion involving hazard type 1 (HT1) or hazard type 2 (HT2) explosives elsewhere on site. Table 2 in Appendix 2 contains further information on when mounds or barricades would be appropriate.

59 Where HT1 or HT2 explosives are not present on site, mounds will not normally be required.

Stock management

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

60 Dutyholders should have a suitable stock management system in place for both ANBI and ammonium nitrate.

61 In its simplest form, a stock management system will involve:

- knowing what stock is present in a facility;
- rotating stock to ensure that the oldest stock is used first;
- checking the position, height and stability of stacks, condition of packaging etc;
- checking to ensure that the stock is in good condition or remains within any recommended shelf-life; and
- consideration of how to manage damaged stock and/or packaging, or stock that is beyond its recommended shelf-life.

62 These objectives can be achieved by:

- recording all movements of ANBI and ammonium nitrate in and out of the store so there is always an up-to-date record of the amount of ANBI and ammonium nitrate. It is recommended that duplicate records are kept in a safe place; and
- leaving a sufficient gap between stacks and walls to allow stock to be inspected, air to circulate freely and any lightning protection to be effective.

63 A suitable stock management system also ensures that appropriate information is available in an emergency, and ensures that the fire and rescue service can be advised of:

- the quantities of ANBI and other explosives involved in the fire;
- the quantities of ANBI and other explosives present elsewhere on site; and
- the hazards that ANBI and any other explosives present.

64 The fire and rescue service should also be advised of the presence and location of other dangerous substances, including ammonium nitrate.

65 A suitable stock management system should also be maintained to enable any compatibility issues between ingredients and products to be monitored and controlled.

Segregating ANBI manufacture and storage from explosives operations

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

66 ANBI manufacture and storage should be segregated from other explosives to reduce the potential for a fire or explosion to spread, and to reduce the extent and severity of any likely event.

Segregating ANBI manufacture and storage from other activities

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

67 Segregating the manufacture and storage of ANBI from other activities reduces the likelihood of the non-explosive activity acting as a source of initiation. It can also ensure that:

- materials involved in other activities do not aggravate the effects of an explosive event; and
- people on site who are not engaged in the manufacture and/or storage of ANBI are appropriately protected should a fire or explosion occur.

68 ANBI and ammonium nitrate should be kept separate from:

- fuels such as flammable liquids, oils, greases, and powdered metals including aluminium powder;
- stocks of combustible materials; and
- other chemicals which are incompatible with ammonium nitrate such as acids, chlorates, zinc, copper and copper salts.

Safely transporting ANBI on site

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

- 69 Care should be taken when ANBI is being transported on site because:
- transporting ANBI can bring it into close proximity with sources of energy capable of causing the ANBI to initiate (eg a fire that engulfs the ANBI following a collision);
 - an event in transport can act as an initiating event for explosives elsewhere on the site, or act as a stepping stone between different quantities of explosives because normal segregation arrangements may not be met; and
 - an event involving ANBI in transport may obstruct an escape route.
- 70 Portable transport tanks used to transport ANBI on an explosives site should either be:
- designed so that they will not confine the ANBI should they be engulfed by fire; or
 - comply with the relevant requirements of ADR.

Preventing fires and explosions

(Regulation 26(1)(a))

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

71 Sources of ignition should be kept away from ANBI or other flammable materials on site that could cause ANBI or ammonium nitrate to initiate.

72 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. Further general guidance on each of these sources of ignition can be found in L150 under 'Protecting explosives from sources of ignition'.

General precautions

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

73 The manufacture and/or storage of ANBI should only be undertaken in a suitable place and within the scope of any licence or other permission. The suitability of the location will depend on the quantity and type of ANBI and the planned activity.

74 The precautions taken to control sources of ignition are covered in detail in paragraphs 81-115. In summary, they include ensuring that any place of manufacture, store, storage area, tank or container is:

- suitably weatherproof;
- designed to ensure that ANBI does not come into contact with substances with which it is incompatible;
- protected by a lightning conductor, where appropriate;

- not used for other activities at the same time that ANBI is being manufactured, processed or kept; and
- kept clean.

75 Tools and equipment should be suitable for the particular conditions of the operation and authorised for use in that operation.

76 Access to manufacturing and storage areas should be restricted to those who need to be present.

77 Equipment and processes should be designed or chosen to prevent ignition and should:

- follow a hierarchy of controls, ie elimination, substitution, reduction, engineering and, finally, personal protection;
- use controls which fail to safety wherever reasonably practicable;
- take into account both normal and abnormal operating conditions, including machinery breakdown or failure, maintenance and decontamination;
- ensure that while equipment is suitable for use in work with ANBI and ammonium nitrate, it does not aggravate other risks or hazards; and
- ensure that any equipment can be thoroughly cleaned, avoiding the uncontrolled build-up of waste ANBI and ammonium nitrate, and ensuring that there is minimal possibility of material remaining in corners and crevices.

78 Buildings used for the manufacture of ANBI and 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.

79 Drains, channels or pits where, in the event of fire, molten ammonium nitrate or ammonium nitrate blasting intermediates could become confined should not be present in buildings used for the manufacture of ANBI or in structures used for the storage of ANBI or ammonium nitrate. Where the presence of drains etc is unavoidable, arrangements should be in place to protect them so that molten material cannot run into them.

80 Floors should be made of non-combustible material without hollows where ANBI or molten ammonium nitrate could concentrate in the event of a fire. Floors should be easy to sweep and clean with water.

Protecting ANBI from sources of ignition

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

81 Suitable precautions should be taken to exclude possible sources of ignition from ANBI and ammonium nitrate.

82 The most common sources of ignition are:

- naked lights and flames;
- heat and temperature;

- electricity (including static electricity and electromagnetic energy);
- sparks from mechanical or frictional contact between metal surfaces;
- pressure;
- impact and friction; and
- chemical incompatibility between certain substances.

83 The sources of ignition which need to be controlled will depend on the site, the activities being undertaken and the outcomes of the hazard identification and evaluation.

Naked lights and flames

Robust systems are in place to prevent the introduction of naked lights and flames into an ANBI facility.

84 Generally, any equipment or article that could introduce a naked light or flame should not be brought into an area where ANBI is manufactured or stored. This means that matches, lighters and smokers' materials should be forbidden from such areas.

85 Only battery- or diesel-powered vehicles should be used in buildings where ANBI is manufactured or where ANBI and ammonium nitrate are stored. Any vehicle used in a building with bulk, loose ammonium nitrate should be fitted with an effective spark arrester to its engine exhaust.

86 Vehicles should only be garaged in places where ammonium nitrate is stored when they are separated from any ammonium nitrate by a firewall offering half-hour fire resistance.

87 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 ANBI facility.

88 Heat and temperature can cause the properties of ANBI and ammonium nitrate to change, and can combine with the oxidising properties of these materials to act as a source of ignition. The three primary sources of heat relevant to safety in ANBI manufacture and storage are:

- heat arising out of pumping operations;
- intentional heating devices; and
- accumulation of ammonium nitrate-based materials on mobile work equipment.

89 Appendix 1 contains detailed guidance on the issues to be considered in the design, selection, operation and maintenance of pumps.

90 Decomposition of ANBI and ammonium nitrate can occur if heaters are positioned too close to it, or if dust deposits are allowed to accumulate on steam pipes or other heating devices. Heating devices should be regularly cleaned to prevent the accumulation of hazardous deposits.

91 Direct electrical heaters (ie fan or radiant heaters) should not be used in ANBI manufacturing areas, or in areas used for the storage of ANBI or ammonium nitrate.

92 Devices (such as hot water or trace heating) used to keep ingredients and products at an elevated temperature should be fitted with a thermal cut-out to prevent overheating.

93 Further information on maximum surface temperatures for heating systems and mobile work equipment can be found in *Guidance for electrical installation and equipment within explosives manufacturing and storage facilities including fireworks*³.

Electrical, electrostatic and electromagnetic energy

Sources of electrical energy are identified and kept to the minimum necessary for the safe operation of an ANBI facility

94 Electrical equipment and installations within any area where ANBI is manufactured or ANBI and/or ammonium nitrate are stored should be confined to that equipment which is essential to the operation of the facility. Where it is necessary to install electrical equipment, it should conform to the relevant standards, and must be designed and constructed to prevent it becoming a source of ignition.

95 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.

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

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.

97 Mechanical sparks do not present the same risk of initiation to ANBI that they do to other explosives. They can, however, cause other materials to ignite, and should be controlled.

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.

98 ANBI is not generally considered to be sensitive to impact and friction, but impact and friction can act as sources of mechanical sparks and heating that can ignite flammable materials or cause ANBI to decompose.

99 Preventative measures should be implemented that either:

- reduce the likelihood of flammable substances being subject to physical force; or
- limit forces so they will not be large enough or delivered in a way that they will cause flammable substances to ignite.

100 These preventative measures should include:

- selecting and maintaining fit-for-purpose tools, plant and equipment;
- laying out workspaces, walkways, passageways and other traffic routes so that the risks of objects being dropped onto, knocking or penetrating flammable substances are as low as reasonably practicable;
- only keeping or working on flammable substances in a designated location;
- keeping flammable substances in appropriate packaging;

- appropriately cleaning, lubricating and maintaining bearings on pumps and other equipment;
- ensuring that people follow a safe system of work, work calmly and without unnecessary or inappropriate haste; and
- maintaining high standards of housekeeping so that potential sensitising agents are not introduced into ANBI or ammonium nitrate.

Pressure

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

101 Pressure, either above a certain level or rapidly applied, can act as a source of initiation during manufacturing and pumping operations.

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

103 Storage tanks for ANBI should either be:

- inherently safe and constructed from materials that will not provide sufficient confinement during a fire to cause the ANBI to explode; or
- fitted with an effective pressure-relief device.

104 Effective pressure-relief devices include reclosing spring-loaded types, frangible discs or fusible elements.

105 The pressure-relief device should be:

- designed to prevent the entry of foreign matter or leakage of the ammonium nitrate blasting intermediate;
- designed and sized so that the contents cannot reach a pressure at which they will burn; and
- subjected to regular inspection, cleaning and maintenance to ensure that it will be effective when called upon to function.

106 Storage tanks for ANBI, including portable transport tanks, should be located:

- on a hard standing with clear access all round; or
- within a bunded area.

107 Any flammable materials that could cause the pressure inside the tank to increase if they were to catch fire should be identified and removed.

108 Caked ammonium nitrate can present an increased risk of explosion, and specialist advice should be obtained from the supplier before it is worked upon or disposed of. Explosives should not be used to break down solidified ANBI or ammonium nitrate, as there is significant risk that the solidified material will detonate.

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.

109 Incompatible substances and/or mixtures can produce significant chemical reactions. These can either generate sufficient heat to cause explosives or other flammable materials to ignite, or produce by-products that are sensitive to sources of ignition.

110 Fuel oil should be stored away from ANBI and ammonium nitrate at a distance adequate to prevent cross-contamination. Tanks containing fuel oil should be bunded, and the bund should be designed to contain 110% of the tank volume.

111 Ammonium nitrate, fuels and other incompatible materials should also be kept separately from one another. Suppliers' guidance on the storage of particular materials should be referred to and followed.

112 Materials that are incompatible with ANBI and ammonium nitrate include in particular copper or copper alloys and zinc.

113 Buildings and work practices used for the manufacture or storage of ANBI and ammonium nitrate should be designed to prevent organic material and other foreign or incompatible materials coming into contact or being mixed with the ANBI and ammonium nitrate.

114 Safety measures intended to prevent chemically incompatible materials coming into contact with ANBI and ammonium nitrate include:

- storing filled bags and intermediate bulk containers in stable stacks;
- keeping walls, floors and equipment clean;
- cleaning up spillages promptly;
- not using organic materials such as sawdust as an aid to cleaning floors;
- disposing of contaminated products promptly and safely;
- not allowing pallets, ropes or covers to become impregnated with ANBI or ammonium nitrate; and
- selecting work equipment, including vehicles, that is constructed of materials suitable for the type of materials being manufactured and stored.

115 Vehicles used to move ANBI or ammonium nitrate around the manufacturing and/or storage area should be checked carefully for any fuel, lubricating or hydraulic oil leaks, as these can become mixed with spilled ammonium nitrate on the floor and form substances which are potentially explosive.

Maintenance systems

The safety measures are properly maintained.

116 Maintenance should include suitable arrangements for:

- identifying the safety measures and any safety-critical systems (including procedures and management arrangements), plant and equipment;
- record keeping;
- planning and prioritisation of maintenance work;
- either planned preventative maintenance or risk-based inspection and maintenance;
- inspection of the safety measures by a competent person at regular specified intervals; and
- reporting and acting on faults with systems, plant, equipment and relevant site infrastructure.

117 The maintenance regime should include a system of periodic inspections of storage areas for ANBI and ammonium nitrate and any manufacturing facilities. Inspections should include checking safety-critical factors such as:

- the condition of the roof and walls or other built structures to ensure they remain stable and provide adequate weather protection;
- the condition of any earthing systems;
- the condition of the floor, in particular to see that there are no cracks where ANBI or ammonium nitrate could accumulate;
- the condition of the internal surfaces, particularly to ensure there are no areas of exposed metal or detachable grit which could present a source of contamination or chemical incompatibility;
- standards of housekeeping are appropriate;
- vegetation and other flammable materials within the site or which could affect it are subject to appropriate control; and
- the ongoing effectiveness of mounds, traverses and other barriers.

118 Maintenance activities often introduce sources of ignition into explosives buildings and areas, so should generally be subject to a high level of control, for example through a 'permit-to-work' system. Equipment and storage areas (or other working areas where ANBI and ammonium nitrate are handled) should be thoroughly cleaned before any maintenance that involves heat such as welding or cutting. In addition to the risks of explosion when these materials are confined and heated, there is also the risk of toxic fumes being produced.

119 Vehicle maintenance activities, or equipment repair activities, should not be undertaken within areas being used for the storage of ANBI or ammonium nitrate.

120 The properties of ammonium nitrate and other ingredients of ANBI can cause deterioration to buildings and equipment. Materials used to construct buildings and equipment should be chosen to take account of these properties and minimise requirements for maintenance.

121 Further information on developing a maintenance regime and controlling maintenance activities can be found in L150 under 'Protecting explosives from sources of ignition'.

Measures to limit the extent of a fire or explosion

(Regulation 26(1)(b))

Appropriate steps are taken to:

- **limit the size of an explosion or fire that may occur;**
- **stop fires spreading; and**
- **limit the size of an explosive event and the area the event affects.**

122 Limiting the severity of a fire or explosion will involve:

- managing stocks of ANBI and ammonium nitrate and limiting them to that necessary for the safe and efficient operation of the undertaking;
- keeping ANBI and ammonium nitrate away from flammable or combustible materials which could fuel a fire or be projected as burning firebrands from an explosion;
- taking appropriate steps to ensure that the ANBI and ammonium nitrate behave as expected and present the hazard considered in the risk assessment; and
- taking reasonably practicable measures to prevent, contain or safely vent blast and pressure and other explosive effects.

123 The measures taken to limit the severity of a fire or explosion will comprise those relevant preventative and protective measures identified in paragraphs 44-70 'Cross-cutting safety measures'. They will also involve emergency arrangements.

124 The key measures to limit the extent of a fire and explosion are to:

- separate storage buildings from production buildings;
- segregate higher-risk materials from lower-risk materials;
- where reasonably practicable, undertake explosives operations in a way that will either contain the effects of a fire or explosion, minimise the severity of the event, or direct or mitigate them in such a way that the likelihood of a fire spreading or an explosion communicating is minimised. For example:
 - fitting vent panels to plant, equipment and buildings that allow a pressure event to vent to a safe place and/or which reduce the likelihood of a fire transitioning to a deflagration or detonation;
 - using physical barriers, including sand and water barriers, to prevent communication and unitise explosives hazards within a facility; and
 - installing drencher and sprinkler systems in facilities where they can be expected to be effective in preventing a fire spreading without introducing unacceptable consequential risks;
- ensuring that ANBI and ammonium nitrate are not left where they can act as a 'stepping stone' to the communication of fire or explosion;

- controlling combustibles, such as waste, unused packaging, vegetation that could become a vector for the spread of fire, or flammable materials generated during grounds maintenance such as grass cuttings etc; and
- implementing the general fire precautions expected by relevant fire safety legislation where they would not adversely affect explosives safety.

125 ANBI storage tanks and ammonium nitrate stores should be separated from other buildings or stocks of flammable materials on or off the site by either:

- a fire-resisting barrier; or
- a fire-break separation distance of 10 m.

126 Fixed storage tanks should be securely located and fixed in accordance with the manufacturer's recommendations, such as on a frame or platform. The tanks should not be fitted with a bund that could act as a source of confinement. Inorganic non-combustible materials should be used for any thermal insulation of the tank.

127 Self-confinement of ammonium nitrate in large stacks can increase the risk of detonation of the whole stack. Stacks of relatively low-density ammonium nitrate (ie below 900 kg/m³) 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/m³ and less than 900 kg/m³;
- 7 m for a pyramidal stack of AN with a density of more than 750 kg/m³ and less than 800kg/m³;
- 9 m for other stacks – with a density of more than 750 kg/m³ and less than 800kg/m³;
- 9 m for a pyramidal stack of AN with a density less than 750 kg/m³;
- 16 m for other stacks – with a density less than 750 kg/m³.

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

128 There should be a space of at least 1 m 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 them to operate in the event of fire.

129 The Safex good practice guide for the safe storage of solid technical grade ammonium nitrate⁷ contains additional information on the storage of relatively low-density AN.

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.

130 Protecting people in the event of a fire or explosion will generally require:

- the number of people in the immediate vicinity of ANBI manufacture and storage areas to be controlled and limited to those necessary to undertake, manage and monitor those activities;
- reasonably practicable engineering controls to be implemented where they will protect people from the effects of a fire or explosion;

- providing personal protective equipment where it would be appropriate to do so; and
- establishing emergency procedures and implementing process and general fire precautions.

Limiting the numbers 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.

131 The number of people present in an area used for the manufacture and/or storage of ANBI and the storage of ammonium nitrate should be controlled, and the manufacture and/or storage of ANBI and the storage of ammonium nitrate should be segregated from other activities. Depending on the nature of the operation, the site and location, controls might include:

- physical controls that only allow access to manufacture and/or storage areas to authorised people;
- providing instructions to people engaged in the manufacture and/or storage operations and to visitors;
- supervising people engaged in the manufacture and/or storage operations and visitors;
- placing signs and notices on doors or at other appropriate places indicating who is authorised to be present, and the maximum number of people permitted in the area at any one time;
- minimising the number of visitors at any one time in a building or area used for a manufacture or storage operation; and
- ceasing operations when visitors or unauthorised persons are present.

Engineering controls

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

132 The engineering controls intended to protect people from the effects of a fire or explosion on an ANBI site will generally be the same as those implemented to limit the extent of a fire or explosion.

Provision of personal protective equipment

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

133 Personal protective equipment can protect individuals by supplementing engineering controls, or by supplementing procedural controls where engineering controls are not reasonably practicable. Further information on the regulatory framework surrounding the selection and use of personal protective equipment can be found in *Personal protective equipment at work. Personal Protective Equipment at Work Regulations 1992 (as amended). Guidance on Regulations L25⁹*.

134 Personal protective equipment intended to protect people from an explosive event would not normally be expected to be worn during the manufacture and storage of ANBI or the storage of ammonium nitrate.

Emergency procedures

Effective emergency procedures are in place.

135 Emergency procedures must clearly set out what dutyholders, employees and others should do and should not do in an emergency. The procedures should normally be written down to allow them to be communicated to others consistently. Information on the procedures must be provided to all employees and others involved in the site's activities.

136 Emergency procedures should cover:

- what constitutes an emergency;
- what to do in the event of an emergency;
- fire precautions relevant to the emergency procedures;
- fire detection and warning systems;
- means of escape and evacuation;
- providing information to the emergency services;
- what to do when the emergency is over;
- identification of places of reasonable safety; and
- how the recovery phase will be managed.

137 Employees should be trained and practised in the actions to take in the event of a fire. This includes deciding whether or not to use portable fire-fighting equipment in the fire's early stages. Portable water fire extinguishers or fire hose reels are appropriate fire-fighting equipment where ANBI or ammonium nitrate is, or might be, involved.

138 Employees should receive appropriate 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.

139 The local fire authority should be informed that ANBI or 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.

140 Where there are homes or businesses in the immediate area, the emergency plans will need to 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 will need to cover periods when the site itself is unattended.

141 Further information can be found in Appendix 4 of L150. It is applicable to sites manufacturing and/or storing ANBI.

Separation distances

(Regulations 27 and 13(6))

Separation distances are met.

Application

142 The safety distances required to be maintained by any licence must be complied with.

143 HSE and ONR will not normally apply separation distances greater than 0 m to ANBI present in containment that is inherently safe, ie that has been demonstrated NOT to provide confinement should the tank be engulfed by fire. Tanks containing ANBI that rely on the effective operation of a mechanical pressure relief device are not generally considered to be inherently safe.

144 When they grant licences for the manufacture and storage of ANBI that require a separation distance greater than 0 m, HSE and ONR will normally follow the separation distances given in Appendix 2.

Buildings which are not normally occupied

145 There are no requirements to maintain separation distances to uninhabited buildings. However, people storing ANBI should bear in mind that such buildings could be re-occupied or redeveloped in the future, at which point the relevant requirements would apply and the applicable separation distances be reviewed.

146 Certain buildings which could endanger an ANBI facility (for example, a high-voltage electrical generating plant) will not normally be inhabited. The requirements of regulation 26 mean that dutyholders will need to take account of the risks posed by such buildings in deciding where it might be appropriate to locate their stores.

147 Further information on the types of building that HSE would generally consider to be unoccupied can be found at <http://www.hse.gov.uk/explosives/licensing/separation/index.htm>

Mounds and traverses

148 The separation distances applied to buildings that are not on the ANBI site will not normally be affected by mounding. This is because the predominant explosive hazard off-site is blast, and mounds would be unlikely to have any significant mitigatory effect.

Application of separation distances and regulation 13(6)

149 HSE or ONR may grant a licence that includes conditions specifying the separation distances to be met.

150 As noted above, when they grant licences for the manufacture and storage of ANBI that require a separation distance greater than 0 m, HSE and ONR will normally follow the separation distances given in Appendix 2.

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

152 Table 2 of Appendix 2 shows separation distances to be maintained between stores holding explosives and stores of ANBI and/or ammonium nitrate. The table does not apply where the stores only hold ammonium nitrate or ANBI. In these instances, only the fire-break distance of 10 m would apply.

153 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 ANBI or ammonium nitrate, or between it and the explosive. Site operators should seek further advice from HSE or ONR on the suitability of natural barricades.

154 ANBI stores and manufacturing facilities should be treated separately from each other for the purposes of determining separation distances where they are separated from each other by the lesser of the:

- 10 m fire-fighting distance; or
- distance in column 2 of Appendix 2, Table 2 where column 1 of the table is taken to be the greater of the quantities of ANBI in each store.

Discarding, disposal and decontamination

(Regulation 28)

ANBI and ANBI-contaminated items are disposed of or discarded safely.

ANBI-contaminated items are safely decontaminated.

ANBI is not considered to be an explosive for the purposes of Regulation 28. However, the principles of safe discard, disposal and decontamination that support the regulation remain applicable when ANBI is being disposed of or discarded, and when ANBI contaminated items are being decontaminated. Dutyholders should be aware that sensitised ANBI and “off-spec” material might be explosives as defined in Regulation 2(9).

Discarding and disposal of ANBI or explosives

ANBI is not discarded as general or household waste.

155 The discard, disposal and destruction of ANBI or explosives can be a high-hazard activity. Failure to dispose of or discard explosives safely is one of the main causes of events and injuries in explosives work.

156 Explosives events can happen because of:

- failure to recognise that ANBI requiring disposal is accumulating in manufacturing, process or storage areas;
- casual attitudes when dealing with the discard or disposal of ANBI, often arising out of a lack of competence or a failure to properly supervise, inspect or audit the activity;
- people not appreciating the properties and behaviour of ANBI under certain conditions (ANBI that requires disposal may be unusually sensitive due to deterioration, contamination and inadequate stabilisation); and
- ill-considered systems of work or no basic safety precautions, often arising out of a failure to identify and evaluate the hazards or a failure to follow prescribed procedures.

157 Specialist advice on safely handling ANBI should be obtained from the supplier if the product has solidified or become contaminated.

158 Further information on the safe disposal of explosives (including ANBI) and explosives-contaminated items can be found in *Guidance for the safe management of the disposal of explosives*⁴.

Decontamination of explosives plant and equipment

159 Decontamination methods will depend on the nature of the buildings, plant or equipment involved. Hazards should be identified and evaluated before starting decontamination work.

160 Particular care should be taken when dismantling a contaminated plant.

Hazard identification, hazard evaluation and risk assessment

161 Consider what measures are required to dispose of, or discard, ANBI safely, or to decontaminate ANBI and ammonium nitrate-contaminated plant and equipment. This will require the hazards associated with the material, the activity and the environment to be identified and analysed. The guidance contained in paragraphs 32-34 of this guidance and in Appendix 1 of L150 should be considered when ANBI is being disposed of or discarded, and when ANBI-contaminated plant and equipment is being decontaminated.

162 Employers and the self-employed will generally identify and implement the controls to ensure that a disposal or decontamination activity is safe as an outcome of their risk assessment process. If they are the operator of an establishment subject to the provisions of the COMAH Regulations, this will be carried out as part of the implementation of a safety management system.

163 Further information can be found in L150 under 'Discarding, disposal and decontamination'.

Vacating an explosives site

Vacated explosives sites are left in a safe state.

164 Any person who vacates an explosives site where ANBI has been manufactured or stored should ensure that any ANBI which is present, as well as any equipment, plant, or any other ANBI-contaminated items, is either safely removed, disposed of, decontaminated, or lawfully transferred to the person who will be in control of the site.

165 An employer or self-employed person storing or manufacturing ANBI has a duty under section 3 of the Health and Safety at Work etc Act 1974 to ensure, so far as reasonably practicable, that their activities do not create risks for persons not in their employment. This applies to risks which might arise from the presence of ANBI at the site after it has been vacated. This means that all buildings and other locations should be cleared of ANBI before they are vacated.

166 Depending on the nature, use, size and history of the site, it may be necessary to seek the advice of a specialist contractor. This is to ensure that all places where ANBI may be present on the site are identified, assessed and, where necessary, decontaminated.

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 in ANBI 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 ANBI being pumped;
- prevent continuous friction leading to heating of a stagnant pocket of ANBI or other energetic materials;
- prevent discontinuous feed of ANBI 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:

- be chemically compatible with ANBI and its ingredients;
- not subject the explosives or any energetic ingredients to excessive friction or temperature; and
- maintain the ANBI below its minimum burning pressure.

4 These requirements should 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 ANBI 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 and *Code of practice: Ammonium nitrate emulsions, suspensions or gels – ANEs (UN3375)*⁶ contain additional information on the selection, operation and maintenance of pumps used in the manufacture and storage of ANBI.

Appendix 2 Separation distances for ANBI

Introduction

1 Tables 1 and 2 contain the separation distances that HSE and ONR will normally apply to sites manufacturing and storing ANBI.

2 Table 2 shows separation distances to be maintained between stores holding explosives and stores of ANBI and/or ammonium nitrate. The table does not apply where the stores only hold ammonium nitrate or ANBI. In these instances, only the fire-break distance of 10 m would apply.

How to use Table 1

3 Column 2 of Table 1 shows two figures in each row for the quantity of ANBI (for example 10–50). This means, in this example, more than 10 tonnes and no more than 50 tonnes.

4 Category 1 distances should be used for industrial units (capable of being evacuated within 45 minutes) and for:

- protected places of Class A (as defined in Schedule 5 to ER2014);
- protected places of Class B;
- protected places of Class C which are capable of being closed to traffic, where appropriate, and which can be evacuated within 45 minutes of a fire starting on the ANBI site;
- protected places of Class D used as industrial premises which are capable of being evacuated within 45 minutes of a fire starting on the ANBI site; and
- isolated dwellings where arrangements are in place for their evacuation within 45 minutes of a fire starting on the ANBI site.

5 Category 2 distances should be used for:

- protected places of Class C that are not capable of being closed to traffic, where appropriate, and which cannot be evacuated within 45 minutes of a fire starting on site; and
- protected places of Class D other than:
 - those which are capable of being evacuated within 45 minutes; and
 - those which house a vulnerable population.

6 Category 3 distances should be used for:

- protected places of Class D which are occupied by a vulnerable population such as young children, older persons and hospital in-patients.

7 Category 4 distances should be used for protected places of Class E.

Table 1 Separation distances to protected places

Category of protected place	Quantity of ANBI (tonnes)	Distance to be maintained to a protected place
Category 1	0.0001–100	0 m
Category 2	0.0001–1	39 m
	1–10	83 m
	10–25	113 m
	25–50	143 m
	50–100	180 m
Category 3	0.0001–1	97 m
	1–10	208 m
	10–25	283 m
	25–50	356 m
	50–100	450 m
Category 4	0.0001–1	165 m
	1–10	355 m
	10–25	484 m
	25–50	610 m
	50–100	767 m

8 For the purposes of this appendix, ‘evacuation within 45 minutes’ means that appropriate and effective arrangements are in place for:

- the evacuation of buildings; and
- the evacuation of persons in the open

within the Category 2 distance.

Determining the separation zone

9 Where there is more than one store on a site, the separation zone is a composite of separation distances around the individual stores.

Deciding the quantity of ANBI to use when it is present in more than one place on site

10 ANBI stores and manufacturing facilities should be treated separately from each other for the purposes of determining separation distances where they are separated from each other by the lesser of the:

- 10 m fire-fighting distance; or
- distance in column 2 of Table 2 where column 1 of the table is taken to be the greater of the quantities of ANBI in each store.

11 Where ANBI stores and manufacturing facilities on a site are separated from each other by a distance less than that required for treating them separately, the quantity of ANBI in the stores and manufacturing facilities will be added together (ie aggregated) for the purposes of determining what net mass in column 2 should be used.

How to use Table 2

12 Column 1 of Table 2 shows two figures in each row for the quantity of explosives (for example 50–100). This means, in this example, more than 50 kg and no more than 100 kg.

Table 2 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

Measuring distances

13 Distances are measured from the outside edge of the building or place where ANBI or explosives are stored to the nearest point of the building or place to which the separation distance applies. The distance should be measured in the horizontal plane. The outside edge of a mound or traverse should not be used for determining the distance to be measured unless it comprises a part of the building or place where the explosives are stored.

Glossary

ADR European Agreement concerning the International Carriage of Dangerous Goods by Road. See www.hse.gov.uk/cdg/manual/adrcarriage.htm#adr for further information.

ANBI ammonium nitrate blasting intermediate, assigned in accordance with the UN Recommendations, the UN no. 3375.

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

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

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

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 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 that 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 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.

HSE the Health and Safety Executive.

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

manufacture the interpretation in the Regulations specifies certain activities that 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 that 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.

minimum burning pressure the ambient pressure below which ammonium nitrate water-based emulsions including ANBI will not sustain combustion.

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.

place of reasonable safety in a non-explosives building, the meaning of 'place of reasonable safety' is the definition in the fire safety legislation guide⁸ :

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 guide⁸ :

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.

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 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 that 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 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 2009 ISBN 978 0 85201 722 7
www.eig.org.uk/eig2007/wp-content/uploads/30777%20BAE%20Systems%20CBI%20GuideV2.pdf
- 4 *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
- 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 *Code of practice: Ammonium nitrate emulsions, suspensions or gels – ANEs (UN3375)* Australian Explosives Industry Safety Group Inc Edition 2 April 2012 ISBN 978 1 921308 12 3
www.aeiscg.org/images/stories/sept12/aeiscg_cop_ane_un3375_ed2_apr12.pdf
- 7 *Good practice guide for the safe storage of solid technical grade ammonium nitrate* www.safex-international.org/index.php
- 8 *Fire safety legislation guide* www.gov.uk/government/collections/fire-safety-law-and-guidance-documents-for-business
- 9 *Personal protective equipment at work (second edition). Personal Protective Equipment at work Regulations 1992 (as amended). Guidance on Regulations L25 (Second edition)* HSE Books 2005 ISBN 978 0 7176 6139 8

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 that manage major hazards such as ANBI. 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

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 ammonium nitrate

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

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 04/16