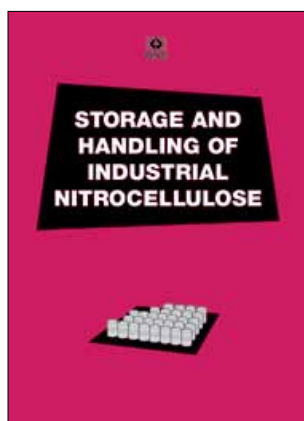


# Storage And Handling Of Industrial Nitrocellulose



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This guidance provides information about the hazards associated with industrial nitrocellulose. It also gives practical advice to protect both stored nitrocellulose and people who live or work nearby from fire.

The guidance is intended to promote a greater understanding of the hazards associated with nitrocellulose and to reduce the injuries and damage that can result from fires involving nitrocellulose.

This book is aimed at those responsible for the storage, handling and use of industrial nitrocellulose and may also be of interest to trade organisations or associations.

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This guidance is issued by the Health and Safety Executive. Following the guidance is not compulsory 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 as illustrating good practice.

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# Preface

The aim of this guidance is to provide information on the hazards associated with industrial nitrocellulose and to give practical advice to protect both stored nitrocellulose and people who live or work nearby from fire. It is aimed at those responsible for the storage, handling and use of industrial nitrocellulose. It may also be of interest to trade organisations or associations who may wish to use the guidance as a basis for more specific guidance for their own members.

The guidance is intended to promote a greater understanding of the hazards associated with nitrocellulose and to reduce the injuries and damage that can result from fires involving nitrocellulose.

Where references to British or other standards are made in this document, equivalent standards which are not specifically referred to but which may exist or be developed are equally acceptable alternatives.

# Introduction

1 This booklet provides guidance on the safe storage, handling and use of industrial nitrocellulose. The main hazard associated with industrial nitrocellulose is fire. Under the Management of Health and Safety at Work Regulations 1992<sup>1</sup> it is the duty of every employer to carry out an assessment of the risks to the health and safety of employees and of anyone who may be affected by the work activity. This is so that the necessary preventive and protective measures can be applied. Precautions which will reduce the risk of a nitrocellulose fire and which will provide protection for nearby people and property if a fire occurs, are outlined in this document. Information on the Management Regulations and other legislation which may be applicable is given in Appendix 1.

2 The advice here does not exclude the use of alternative designs, materials and methods where these provide an equivalent or higher overall level of safety. At existing premises, there may be difficulties in adopting all the recommendations but improvements which are considered to be reasonably practicable or essential for safety should be made. Advice on the application of the guidance to specific sites may be obtained from the enforcing authority (see Appendix 1).

3 Industrial nitrocellulose is commonly referred to simply as nitrocellulose. Both terms are used throughout this booklet. An alternative name which may be encountered on occasion is cellulose nitrate.

# Definition of industrial nitrocellulose

4 Industrial nitrocellulose is used as a basic ingredient in many paints, lacquers, varnishes, packaging films, printing inks, adhesives and leather and fabric finishes. It is produced as dense granules, fibrous grades and densified grades (which are intermediate between the dense and fibrous forms). It is supplied mixed with various desensitizers (also known as damping or wetting agents) to reduce its sensitivity to ignition by friction or impact during transportation, storage and handling. The most commonly used desensitizing agents include the following:

- (a) solvents - isopropanol, industrial methylated spirit, n-butanol, methanol;
- (b) plasticisers - dibutyl phthalate, dicyclohexyl phthalate, dioctyl phthalate;
- (c) water.

5 This guidance applies only to the nitrocellulose mixtures listed below, which are classified under the United Nations Recommendations for the Transport of Dangerous Goods<sup>2</sup> as Division 4.1 Flammable Solids:

- (a) *Nitrocellulose with alcohol* – not less than 25% alcohol by mass, and not more than 12.6% nitrogen by dry mass;
- (b) *Nitrocellulose with plasticizing substance* – not less than 18% plasticizing substance by mass and not more than 12.6% nitrogen by dry mass;
- (c) *Nitrocellulose with water* – not less than 25% water, by mass.

These definitions are also used in the UK classification, packaging and transport regulations<sup>3</sup>.

6 This guidance does not apply to nitrocellulose mixtures with more than

12.6% nitrogen which are Class 1 Explosives. Neither does it apply to Class 3 nitrocellulose solutions which are defined as flammable, with not more than 12.6% nitrogen by mass, and not more than 55% nitrocellulose. These should be treated, where appropriate, as flammable liquids for which other HSE guidance<sup>4</sup> is available.

## Fire hazards

7 Industrial nitrocellulose (other than water wetted) is a considerable fire hazard. It is easily ignited and burns fiercely, emitting large quantities of heat and toxic fumes. Under certain circumstances, eg if incorrectly packaged and stored in a confined space, it may explode. The burning rate depends on the type and quantity of desensitizing agent present. When alcohol wetted grades are ignited, the initial burning rate is that of the alcohol, but as burning proceeds, the fire becomes fiercer. Wet grades which have partly or completely dried out and plasticised grades produce bigger, hotter fires.

8 The type of packaging, usually steel or fibreboard drums, may also influence the fire behaviour. For example, steel drums may vent their contents violently, causing short duration fireballs. Drums and lids may be projected considerable distances, particularly if venting occurs with the drum in a horizontal position. The radiation produced by these effects will add to the heat from the material in the stack and on the ground. Industrial nitrocellulose in fibreboard drums burns more evenly than when packed in steel drums, the dimensions of the fire and duration of burning relating fairly closely to the quantity stored and the stack configuration. The exception is plasticised material which may be violently ejected even from fibreboard drums. As with steel drums, the main effect of violent ejection will be to increase the flame width of the fire around the stack.

9 In addition to burning much faster than the solvent wetted grades, plasticised grades of industrial nitrocellulose are also more susceptible to ignition from frictional heating. These properties, particularly the high rates of burning, are significant and therefore you should consider them when you assess any store where these grades could be kept in substantial quantity.

10 Water wetted nitrocellulose is relatively insensitive to heat compared with other grades so is not immediately affected by fire. It does not present a great fire risk provided you make reasonable precautions to minimise the exposure of stored material to prolonged heating by an external fire.

11 It is important that the desensitizing agent is not allowed to evaporate because as the nitrocellulose dries out, it becomes increasingly more heat and friction sensitive and potentially more dangerous to handle, particularly in quantity.

12 All grades of nitrocellulose are incompatible with strongly alkaline or strongly acidic materials and oxidising agents. Contamination by any of these substances could result in decomposition and ignition of the nitrocellulose.

13 Further details of the variation in heat output with quantity and distance from burning stacks of different grades of nitrocellulose in both steel and fibreboard drums are contained in a published report of tests carried out by the Health and Safety Executive<sup>5</sup>.

# Drum storage

## Location

14 An assessment of the fire risk from or to a nitrocellulose store will form part of the risk assessment required by the Management of Health and Safety at Work Regulations 1992<sup>1</sup>. The principal objectives when considering the location of a nitrocellulose drum store are:

- (a) to minimise the risk of a fire occurring in the storage area itself;
- (b) to mitigate the consequences of such a fire, particularly with regard to people;
- (c) to protect the store from fires occurring elsewhere.

15 The overriding concern is to ensure that in the event of a fire in the storage area people are able to escape to safety. As mentioned in paragraph 7 nitrocellulose burns fiercely, emitting large quantities of heat and toxic fumes. It is advisable therefore to consider conditions not only on site but beyond the site boundary also. The quantities and locations of other dangerous substances are also relevant to the assessment, particularly in the context of preventing escalation of an incident.

## Separation

16 The use of separation as a protective measure for the storage of dangerous substances such as highly flammable liquids and liquid petroleum gas is well documented<sup>6</sup>. Separation has particular advantages because not only does it protect people (and property) from the effects of a fire in the store itself but it also protects the store from fires which may occur elsewhere on site. Consequently, separation is considered an important means of protection for industrial nitrocellulose storage.

17 Separation distances depend on various factors, including the quantity of nitrocellulose, how it is stored and whether the location is considered to be 'high risk' or not. 'High risk' locations are generally considered to be those where vulnerable populations or large numbers of people may be put at risk. Vulnerable populations include the sick, the old, the disabled and the very young, ie hospitals, nursing homes, schools. Large numbers of people may be found in office blocks, residential premises, shopping centres etc.

18 As mentioned in paragraph 13, burning trials were carried out by HSE to determine the variation in heat output with quantity and distance from burning stacks of different grades of nitrocellulose in both steel and fibreboard drums. These trials were carried out in the open air for single and double drum stacks. The results were used to determine the separation distance required to reduce the thermal radiation level to  $12.6 \text{ kW/m}^2$ . ( $12.6 \text{ kW/m}^2$  is the separation criterion quoted in Approved Document B<sup>7</sup>, issued in support of the Building Regulations 1991, for the prevention of fire spread between buildings.)

19 The equations derived from these trials are given in Table 1. The separation distance required to reduce the thermal radiation level down to  $12.6 \text{ kW/m}^2$  for a particular stack size can be determined using these equations or perhaps more simply from the associated graph (Figure 1). Note that the separation distances are dependent on the width of the stack and therefore will vary with the stack shape or configuration. In addition, the data is not valid for drums stacked more than two high.

**Table 1** Calculation of separation distances for industrial nitrocellulose

The following equations may be used to determine D, the separation distance from outdoor stores of nitrocellulose of width W. They are specifically applicable to 'high risk' situations (see paragraph 17) and stocks in excess of 50 te.

<i>Grade</i>	<i>Drum type</i>	<i>Stack height</i>	<i>For an irradiance of 12.6 kW/m<sup>2</sup> (see Figure 1)</i>
Plasticised	Steel or fibreboard	Double drum	$D = 30.70 W^{0.3635}$
Plasticised	Steel or fibreboard	Single drum	$D = 25.48 W^{0.3584}$
Solvent-wetted	Steel	Double drum	$D = 21.30 W^{0.3724}$
Solvent-wetted	Steel	Single drum	$D = 17.65 W^{0.3740}$
Solvent-wetted	Fibreboard	Double drum	$D = 18.32 W^{0.3737}$
Solvent-wetted	Fibreboard	Single drum	$D = 15.08 W^{0.3811}$

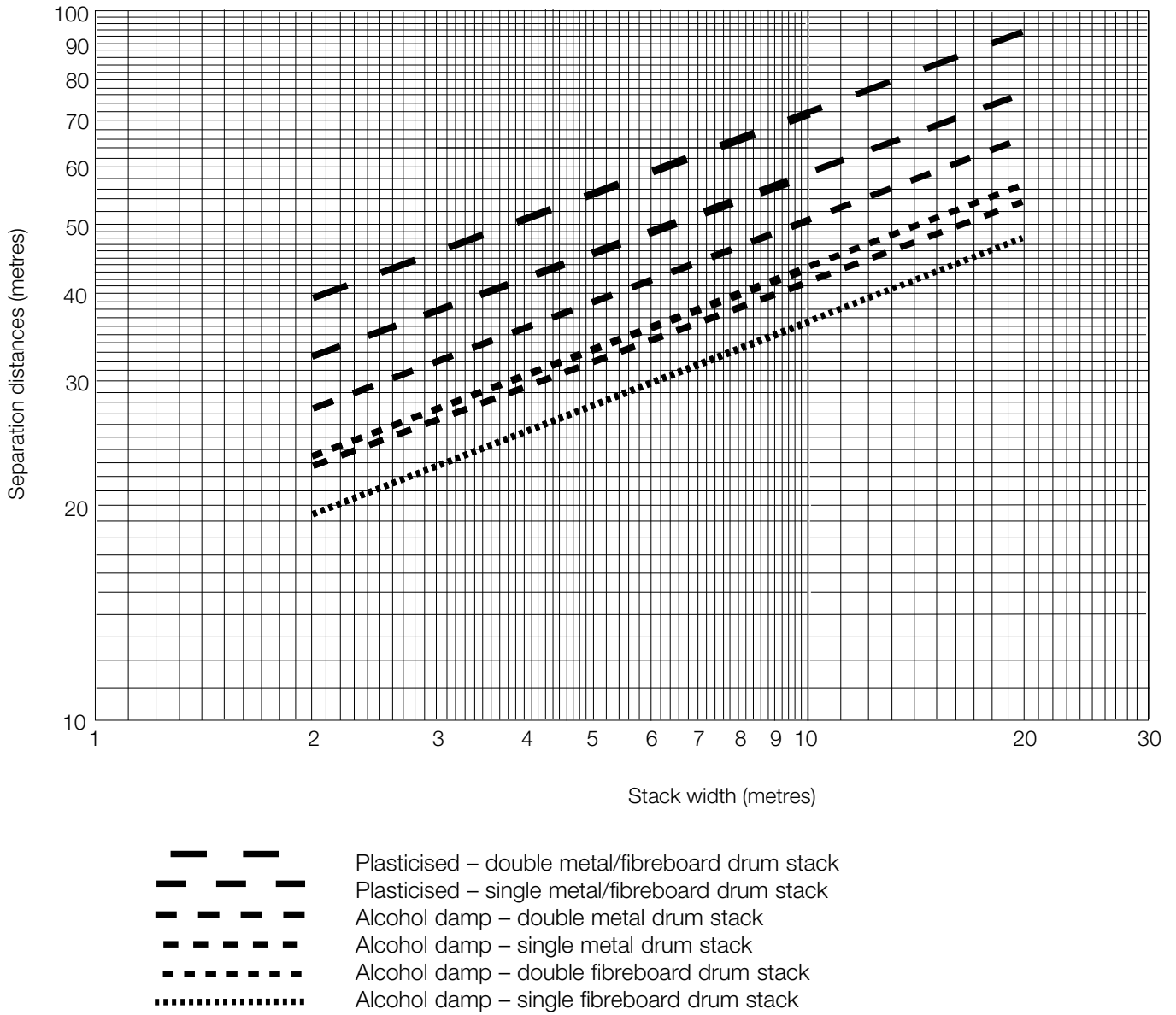
If it is necessary to provide separation distances for some other irradiance level (eg 20 kW/m<sup>2</sup> for piloted ignition of plastics, 25 kW/m<sup>2</sup> for the spontaneous ignition of wood, 38.5 kW/m<sup>2</sup> for the protection of large HFL tank storage), the inverse square law may be used with values obtained for 12.6 kW/m<sup>2</sup> above, to determine a reasonable approximation by the following equation:

$$D_2 = [I_1 \times D_1^2 / I_2]^{0.5}$$

where:  $I_1$  and  $I_2$  are the irradiances at distances  $D_1$  and  $D_2$  metres respectively.



Figure 1 Stack width (metres) v separation distance (metres) for an irradiance of 12.6 Kw/m<sup>2</sup>



20 The separation distances obtained from Table 1 are considered to provide sufficient protection to allow the safe evacuation of people in buildings. They are the minimum recommended for the so called 'high risk' scenarios (as described in paragraph 17) and for large stocks of nitrocellulose in excess of 50 te. Greater separation distances or protection may be required under certain circumstances, eg where there may be large numbers of people in the open air.

21 The separation distances obtained from Table 1 are primarily for storage of nitrocellulose in the open air, without any additional fire protection measures. It may be possible to reduce the distances by the use of fire protection measures such as a fire resistant storage building (paragraph 27), fire walls (paragraph 23) or water spray protection (paragraph 56).

**Table 2** Separation distances for industrial nitrocellulose storage

<i>Total quantity stored (kg)</i>	<i>A Separation distance (where no fire wall is provided) (metres)</i>	<i>B Separation distance (where a fire wall is provided) (metres)</i>
50 - 1000	3	1
1000 - 5000	4	2
5000 - 10 000	7.5	4
10 000 - 25 000	10	5
25 000 - 35 000	15	7.5
35 000 - 50 000	20	10
Above 50 000	see Figure 1	

The table shows the minimum recommended separation distance from the nitrocellulose store to occupied buildings, the site boundary and hazardous substance storage for 'low risk' scenarios (see paragraphs 22 and 25). It applies only to stores where the drums are stacked not more than two high.

22 For situations where the risk to people is considered to be low shorter separation distances are generally justifiable. Examples of these include buildings which are only occasionally occupied by low numbers of people or buildings which have sufficient fire resistance to protect a low level of occupancy. Table 2 (column A) provides information on separation distances which may be appropriate in these circumstances. These distances are unlikely to give complete protection in the event of a fire in the nitrocellulose storage area but should allow sufficient time for people to be evacuated, provided there are good means of escape and the people at risk are not particularly vulnerable. Distances less than those given in column A are unlikely to be adequate unless additional protection, such as a fire wall, is provided. Again, the distances given are only applicable to drums stacked not more than two high.

23 Column B indicates the potential reduction of the separation distances if a fire wall is used. A suitable fire wall for this purpose would be of at least of 30 minutes fire resistance, imperforate, preferably of brick or concrete and at least as high as the highest stack, with a minimum height of 2 m. However, barriers of other materials, eg earth banking, may be equally effective. Other options which may be considered include water spray protection (paragraph 56) and the use of a fire resistant storage building or room (paragraph 27).

### Separation from dangerous substances

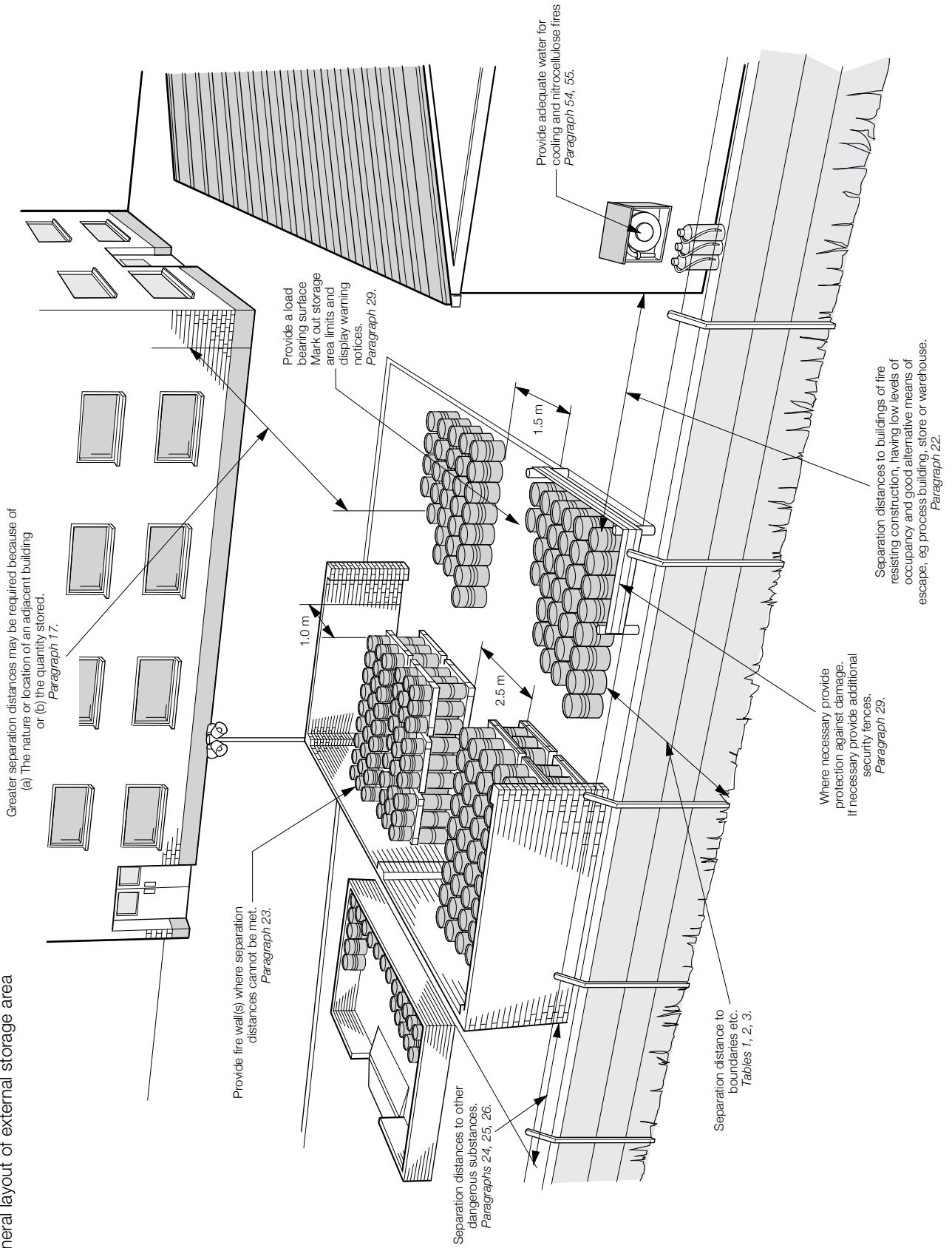
24 Separation may also be used to prevent or delay the spread of fire to other storage or process areas where hazardous materials are present in quantity. It is recommended that nitrocellulose is stored in a building, building compartment or outdoor storage compound, separate from:

- (a) incompatible materials such as strong acids and alkalis, oxidising agents and any other unstable or heat sensitive substance; and
- (b) compressed gases and liquids (eg liquefied petroleum gas and liquid oxygen) which may become overpressurised in a fire.

It is also important that nitrocellulose is sufficiently separated from flammable liquids and other combustible material.

25 Table 2 may be used to estimate the appropriate separation distances from other dangerous or combustible substances. For substances where published HSE guidance already exists, the recommended separation distance is the greater of the distances given in Table 2 and in the appropriate HSE guidance. However, the separation between solvent wetted nitrocellulose storage and flammable liquid drum storage may be determined using Table 3, provided the overall fire risk is considered to be low. (Table 3 is taken from HS(G)51 *The storage of flammable liquids in containers*<sup>6</sup>.)

Figure 2 General layout of external storage area



**Table 3** Separation distances for industrial nitrocellulose storage from flammable liquid storage in drums

<i>Total quantity stored (litres of HFL)</i>	<i>Distance from nitrocellulose (metres)</i>
Up to 1000	2
1000 - 100 000	4
100 000 - 300 000	7.5
Above 300 000	7.5

The table shows the minimum recommended separation distance from the nitrocellulose store to flammable liquid storage in containers<sup>6</sup>. It applies to solvent wetted nitrocellulose only, stacked no more than two drums high.

26 Again, these separation distances are unlikely to give complete protection but should delay the spread of fire allowing people to escape and emergency plans to be initiated. It is important therefore that any potential domino effects involving other dangerous substances are considered, including contamination of local water courses (paragraph 58).

### **Fire resistant storage buildings or storerooms**

27 A detached storage building or a dedicated room in a building may be used. The main features to incorporate include:

- (a) a standard of fire resistance which will allow adequate time, in the event of a fire in the store, for the alarm to be raised and for people to escape;
- (b) good means of escape from the store itself. It is also essential that the location of the store does not put at risk escape routes from any other part of the site. This is particularly important if the store is in a building;
- (c) a lightweight roof or relief panel, positioned so that, in the event of a fire, escaping heat and fumes are directed to a safe place.

Further advice on the design and construction of fire resistant storerooms and buildings is given in HS(G)51 *The storage of flammable liquids in containers*<sup>6</sup>.

### **Sources of ignition**

28 Sources of ignition, within or near the nitrocellulose storage area, should be strictly controlled. The following measures are recommended:

- (a) banning of smoking and other ignition sources such as matches or lighters in the storage area;
- (b) excluding all process activity from the store, including dispensing;
- (c) controlling construction or maintenance work that could affect the safety of the stored material, particularly when it involves hot work. A permit-to-work system may be necessary.
- (d) controlling the use of electrical equipment. The Electricity at Work Regulations 1989<sup>8</sup> require electrical equipment which may be exposed to flammable substances to be constructed or protected to prevent danger arising from such

- exposure. Advice on electrical equipment for use in hazardous areas is given in HS(G)22 *Electrical apparatus for use in potentially explosive atmospheres*<sup>9</sup>;
- (e) adequate separation from heat sources such as steam pipes;
  - (f) protection against prolonged exposure to strong sunshine. This may take the form of a non-combustible canopy or shade;
  - (g) a high standard of housekeeping to ensure that the store is kept free of combustible rubbish (including vegetation) which may contribute to the fire risk.

### **Restricted access**

29 It is advisable to restrict access to the store by unauthorised people and vehicles. This may prevent accidental damage to drums and the introduction of uncontrolled ignition sources. For outdoor storage, it may be useful to mark the extent of the storage area or erect suitable barriers. The standard of security at the store will depend not only on the conditions in the area surrounding the store but also on the general level of security at the premises. It is recommended that nitrocellulose is stored on a concrete or similar impervious load bearing surface.

### **Notices**

30 The posting of warning notices at the entrances to stores containing nitrocellulose is recommended, to indicate:

- (a) that it is a nitrocellulose store;
- (b) that the materials stored are flammable solids and, where appropriate, that they also contain highly flammable liquids;
- (c) that smoking and other ignition sources are prohibited;
- (d) the procedure to be followed in case of fire.

If pictorial signs are provided they should conform to the Health and Safety (Safety Signs and Signals) Regulations 1995<sup>10</sup>. In certain circumstances the Dangerous Substances (Notification and Marking of Sites) Regulations 1990<sup>11</sup> may apply (see Appendix 1). These Regulations make specific requirements for the posting of hazard warning signs and the design of the signs to be used.

## Drum handling

31 Industrial nitrocellulose is supplied usually in either heavy galvanised steel or fibreboard drums. The drums have a nominal capacity of 240 litres and, depending on the grade contain between 120 kg and 147 kg of nitrocellulose. Steel drum lids are designed to be impervious to liquid and airtight but to separate at a pressure below 296 KPa (43 psi) if a drum becomes pressurised due to a fire. Fibreboard drums may have metal, wood or fibreboard lids.

32 Rough handling can cause damage to drums or their lids, leading to spillage or loss of damping agent. Friction or impact can also cause ignition of the nitrocellulose. The following handling methods in particular are considered unsatisfactory:

- (a) handling drums by cask or drum slings, or drum hooks and chains;
- (b) carrying drums horizontally between the forks of a fork-lift truck;
- (c) transporting odd unsecured drums on top of other drums;
- (d) rough handling techniques including dropping, rolling, dragging, scraping or pushing of drums on hard surfaces such as concrete, tarmacadam or steel floors.

Handling methods should be assessed to minimise the risk of damage or personal injury.

33 The most widely accepted method of handling nitrocellulose drums is to use a fork-lift truck to carry unit loads on pallets. A unit load will normally consist of four metal drums or up to eight fibreboard drums, securely strapped together by rope or other appropriate fastening. It is advisable to move only one pallet load of banded drums at a time. It is also good practice to examine loads before moving, so that any drums with damaged lids or closure rings can be isolated from the stock.

34 The pallets should be stacked in a safe manner and in a way which minimises the amount of handling. This is best achieved by keeping the drums banded together on the pallets until required and not stacking them more than two high. Handling pallet loads composed of either non-standard numbers of drums or drums of different heights or weights may require additional care. A hazard may be created if other pallets are placed on top of them without additional support to stabilise the stack. Stacking of loose drums is not recommended. It is clearly an advantage if deliveries can be arranged as unit loads so that drums can be kept strapped together during unloading, stacking and storage.

35 Individual drums may be moved short distances by using a fork-lift truck fitted with the appropriate drum clamps or by using a suitable drum truck. Trundling drums on their bottom rim may cause damage to drums and injury to personnel. If drums are handled manually, it should be noted that there are specific requirements under The Manual Handling Operations Regulations 1992<sup>12</sup>.

36 Drums may also be damaged if the gangways between stacks are not wide enough for the method of handling used. Gangways of not less than 1.5 m where single drums are handled manually or 2.5 m for palletised drums using a fork-lift truck are usually adequate. In addition, it is important to ensure that drums are not unduly confined such as by stacking them close to building walls or fire walls. It is recommended that, for stocks in excess of 500 kg nitrocellulose, a space of at least 1 m is provided between the drums and the wall. The provision of such spaces and gangways will also ensure ready access to all parts of the storage area, facilitating visual inspection.

37 Visual inspection on a regular basis is advisable to check that there is no damage to a drum, accidental heating or ageing or some combination of these causes which could cause deterioration in the condition of the nitrocellulose, eg through loss of solvent. Allow any drums that have been heated to cool for 24 hours before opening, so that the solvent can remigrate evenly through the nitrocellulose. Careful stock control can reduce potential problems by ensuring that the nitrocellulose is used in rotation, beginning with the oldest stock and by minimising stocks to a level compatible with normal production and delivery requirements. Advice on product shelf-life may be obtained from the supplier.

38 All drums should be clearly labelled. Drums as delivered should already be labelled in accordance with the Chemicals (Hazard Information and Packaging) Regulations 1994<sup>3</sup>. It is generally preferable to stack full and empty drums separately.

39 It is advisable to maintain a record of the contents of the store, which is sufficient for the emergency services to judge the type and scale of the hazard if an incident occurs. The necessary information will include an up-to-date record of the quantity stored and details of the likely hazards.

40 If required, advice on the safety of loads on vehicles is contained in the Department of Transport Code of Practice<sup>13</sup>.

## Handling and use

41 Drums containing nitrocellulose damped with a highly flammable liquid should be opened only in areas which conform to the Highly Flammable Liquids and Liquefied Petroleum Gases Regulations 1972<sup>4</sup>. Advice on electrical apparatus for use in potentially explosive atmospheres is given in HS(G)22<sup>9</sup>. If accumulations of combustible dusts are possible, electrical equipment should be provided to BS 6467<sup>14</sup>.

42 Solvent wetted grades are often packed inside a polythene bag or liner within the drum. The purpose of the liners is to minimise the loss of wetting agent, and prevent spillage and contamination if a drum is damaged. However, care is needed when handling the liner to avoid the hazard of ignition from any accumulation of electrostatic charge. It is recommended that drums are opened carefully and that the liner is folded back over the rim of the drum.

43 Nitrocellulose can also generate an electrostatic charge when being poured or scooped from one container to another. Precautions to prevent the accumulation of electrostatic charge include:

- (a) ensuring that all drums, liners and loading chutes are effectively earthed during such transfer operations. Nitrocellulose should not be transferred either from or to any unearthed container or vessel;
- (b) using scoops made from suitable conducting materials, such as stainless steel or copper/beryllium alloy. Scoops made from insulating materials, eg some plastics, are not generally appropriate;
- (c) wearing anti-static clothing and footwear.

Further information may be obtained from the supplier or from the British Standards Institution Code of Practice *Control of undesirable static electricity*<sup>15</sup>.

44 It is important that drum lids are replaced immediately after use to prevent



the evaporation of any desensitizing agent and to minimise the likelihood of the contents of the drum becoming contaminated. When no longer required in the workroom it is good practice to return empty or partly used drums, appropriately marked, to the drum storage area.

45 The use of empty drums for other purposes is not recommended as they may contain residual nitrocellulose or solvent. Empty drums may be cleaned out provided this is done in accordance with the supplier's recommendations.

46 All spillages should be cleared up immediately. The recommended method is to completely wet the nitrocellulose with water, deposit it in a metal container with a close fitting lid and remove it to a safe place, separate from the main storage compound. Waste nitrocellulose and any contaminated cleaning materials or cloths should be disposed of in accordance with advice from the supplier. The destruction of nitrocellulose by burning requires specific precautions and such operations should not be undertaken unless conducted in a safe location by adequately trained personnel (see also paragraphs 48-50).

47 It is good practice to regularly wash the walls, ceilings and floors of processing areas to prevent the accumulation of dry nitrocellulose dust.

## Disposal of waste nitrocellulose

48 Waste nitrocellulose may be disposed of by burning in an unconfined and safe manner out of doors, or by dissolution or dilution. However, it is important that advice regarding the method of disposal and the possible environmental implications is obtained from the local waste disposal authority or the supplier.

49 In planning for the disposal of waste it will be necessary to:

- (a) establish the quantity that could be produced daily/weekly and set stock limits or frequency of disposal;
- (b) decide on a suitable method of disposal; in most cases this will be by unconfined burning, but other ways include dissolution or dilution by a solvent and drowning in water;
- (c) select a suitable disposal site; this should be a remote level piece of ground with no flammable substances or combustible matter, including vegetation, in the immediate vicinity and downwind of occupied buildings etc. There should be access to a good readily available supply of water with the necessary hydrants and hoses;
- (d) take into account any limitations or requirements imposed by the Environmental Protection Act 1990<sup>16</sup>;
- (e) select and train those who will carry out the work and provide them with suitable protective equipment including non-combustible/fire retardant clothing, gloves, boots and head/face protection;
- (f) issue appropriate instructions such as a written system of work.

50 Although it is not directly concerned with industrial nitrocellulose, HS(G)36 *Disposal of explosives waste and the decontamination of explosives plant*<sup>17</sup> gives guidance on disposal methods for some similar materials. In cases of doubt, contact the local enforcing authority.

## Information and training

51 Providing adequate training and information is essential for the safe use and handling of nitrocellulose and is also a requirement of The Management of Health and Safety at Work Regulations 1992<sup>1</sup>. The extent of the information, training and retraining should be identified by the risk assessments carried out under the requirements of these regulations.

52 All personnel on the site should be informed of the hazards from industrial nitrocellulose, and of the need to exclude sources of ignition and heat. Those handling nitrocellulose should also receive specific training in both normal operating procedures and emergency procedures. Periodic retraining will usually be necessary. The training should cover the following:

- (a) the properties and hazards associated with the grades of material handled and the relevant legal requirements;
- (b) general procedures for safe handling and operation of plant;
- (c) use of protective clothing;
- (d) housekeeping, including dealing with empty containers and scrap material;
- (e) procedures for dealing with damaged drums, off-specification product, etc;
- (f) reporting faults and incidents;
- (g) emergency procedures, including raising the alarm, and use of appropriate fire-fighting equipment.

Procedures for controlling the risk from the use and handling of nitrocellulose should be provided in writing and used as a basis for training.

## General fire precautions

53 The possibility of a major fire and its uncontrolled escalation can be minimised by good plant design and layout, sound engineering, good operating practice and proper instruction and training of personnel in routine operations and emergency procedures. Plant design and layout should include consideration of water supplies, fire protection equipment, fire-fighting, means of escape, means of access for fire brigade appliances, protection of fire-fighters and arrangements to ensure an early call out of the fire brigade in the event of fire. The fire authority should be consulted on these matters, at the planning stage in the case of new or altered facilities.

54 Water is the only effective means for fighting a nitrocellulose fire, for flooding unburnt material and cooling drums at risk. Chemical and carbon dioxide extinguishers should not be used as they are ineffective. The adequacy of the water supply available for fighting a fire at the store should also be discussed with the local fire authority.

55 For stores of up to 50 000 kg there should be sufficient water available to fight a fire in the store and protect surrounding plant and buildings for at least an hour. This should be readily available but may be provided via public mains, or pumped from a static tank, river, canal, etc. Hydrants and hoses with spray/jet nozzles or hose reels should be installed so that any stack of drums may be effectively sprayed with water.

56 For larger stores, alternative means of applying water to nitrocellulose fires should be considered, eg portable monitors or fixed sprays. Fixed water sprays or fixed monitors may also be provided where there could otherwise be particular problems in achieving satisfactory conditions for storage, eg because of inadequate

distances for separation or where a very large stock could be at risk. Suitable minimum application rates for water spray protection, based on the storage area which the drums will cover, are 12.5 litres/m<sup>2</sup>/min for alcohol wetted grades and 20 litres/m<sup>2</sup>/min for plasticised grades. An adequate supply should be available to provide water at the required rate for at least one hour. Special consideration should be given to the possibility that there could be a loss of power to the site and the consequences that this could have for the fire-fighting arrangements provided.

57 Suitable access to the store should be provided and maintained for fire brigade personnel, vehicles and other equipment.

58 Where necessary adequate drainage should be provided to deal with water used for fire protection and fire-fighting, to minimise environmental damage. Interceptors or special drainage systems may be necessary, particularly at large installations, to minimise the risk of contamination of local water courses. Consultation with the water authority and the fire authority may be appropriate.

## Emergency procedures

59 The impact of any incident on people and premises can be drastically reduced if established measures are implemented at the earliest stage. Written emergency procedures should therefore be prepared, setting out the actions to be taken in the case of fire. These should cover both fires directly involving nitrocellulose and fires occurring in the vicinity of a nitrocellulose process or store. These procedures should describe how to:

- (a) raise the alarm and call the fire brigade;
- (b) evacuate the site and nearby premises, if necessary;
- (c) control the incident and mitigate its consequences, provided that this can be done safely.

The procedures should be practised at regular intervals to ensure that everyone is familiar with the actions to be taken in an emergency.

60 Where foreseeable incidents may affect persons or property beyond the site boundary, the emergency services should be consulted when preparing the procedures. At sites subject to regulations 7 to 12 of the Control of Industrial Major Accident Hazard Regulations 1984<sup>18</sup> formal on site and off site emergency plans are required.

# Appendix 1 legal requirements

## 1 *Health and Safety at Work etc Act 1974 (HSW Act)*

The HSW Act<sup>19</sup> is concerned with securing the health, safety and welfare of people at work, and with protecting people who are not at work from risks to their health and safety from work activities. The HSW Act and its relevant statutory provisions are used to control the keeping and use of explosive or highly flammable substances and are concerned with precautions against the outbreak of fire in all work activities. The HSW Act is enforced either by HSE or by local authorities, as determined by the Health and Safety (Enforcing Authority) Regulations 1989<sup>20</sup>. Further advice on these matters is obtainable from local area offices of HSE or the environmental health department of the local authority, as appropriate. Guidance on the Act is also available in an HSE booklet *A Guide to the Health and Safety at Work etc Act 1974*<sup>21</sup>.

## 2 *The Management of Health and Safety at Work Regulations 1992*

These Regulations<sup>1</sup> require all employers and self-employed people to assess the risks to workers and others who may be affected by their undertakings so they can decide on the appropriate measures they need to take to fulfil their statutory obligations. These Regulations also require an assessment to determine the requirements for appropriate health and safety arrangements, health surveillance, emergency planning, provision of information and training. An Approved Code of Practice gives guidance on the provisions of these Regulations.

## 3 *Chemicals (Hazard Information and Packaging) Regulations 1994*

These Regulations<sup>3</sup>, commonly referred to as the CHIP 2 Regulations, contain requirements for the supply of chemicals. The Regulations require the supplier of chemicals to identify the hazards of the chemicals they supply, to give information about the hazards to the people they supply and to package the chemicals safely. The Regulations are supported by an Approved Supply List<sup>3</sup> containing agreed classifications for some common substances, an *Approved Code of Practice on safety data sheets*<sup>3</sup> and by the guidance booklet *CHIP for everyone*<sup>3</sup>.

## 4 *The Carriage of Dangerous Goods by Road and Rail (Carriage, Packaging and Labelling) Regulations 1994*

These Regulations require consignors of dangerous goods to ensure that their goods are properly classified, and packaged and labelled in accordance with that classification. The Regulations apply to all the more common classes of dangerous goods (but not explosives or radioactive substances). Most of these dangerous goods are already classified and listed in an associated publication, the Approved Carriage List<sup>3</sup>. If a substance is not already classified, guidance is contained in the *Approved methods for the classification and packaging of dangerous goods by road and rail*<sup>3</sup>.

## 5 *The Road Traffic (Carriage of Dangerous Substances in Packages etc) Regulations 1992*

These Regulations<sup>3</sup> control the carriage of dangerous substances in packages. They include requirements on the suitable construction of vehicles and freight containers, the keeping and provision of information, the loading, stowage and unloading of dangerous substances, precautions against fire and explosion and the marking of vehicles carrying dangerous goods.

#### 6 *The Highly Flammable Liquids and Liquefied Petroleum Gases Regulations 1972*

These Regulations<sup>4</sup> apply when liquids with a flashpoint of less than 32°C and which support combustion (when tested in the prescribed manner) are present at premises subject to the Factories Act, 1961<sup>22</sup>. An exception to the storage requirements of these Regulations applies where a petroleum licence is in force.

#### 7 *The Petroleum (Consolidation) Act 1928*

The Act<sup>23</sup> defines petroleum and petroleum spirit and requires the keeping of such liquids to be authorised by a licence, and to be in accordance with any conditions attached to the licence. The Petroleum (Mixtures) Order, 1929<sup>24</sup> extends these requirements to petroleum mixtures which are defined in the Order.

#### 8 *The Factories Act 1961*

The Act<sup>22</sup> defines a 'factory' and contains many general and detailed provisions relating to work activities in factories.

#### 9 *The Electricity at Work Regulations 1989*

These Regulations<sup>8</sup> impose requirements for electrical systems and equipment, including work activities on or near electrical equipment. They also require electrical equipment which is exposed to any flammable or explosive substance, including flammable liquids and vapours, to be constructed or protected to prevent danger.

#### 10 *The Health and Safety (Safety Signs and Signals) Regulations 1995*

These Regulations<sup>10</sup> are expected to come into force in 1995. They will supersede the Safety Signs at Work Regulations 1980. They detail the requirements to provide, maintain and use a sign where a risk assessment has indicated a need for a sign to warn of a hazard that cannot be prevented or controlled effectively by other means. Generally, signs that are detailed in BS 5378: *Safety signs and colours*<sup>10</sup>, will meet the requirements of these Regulations.

#### 11 *The Dangerous Substances (Notification and Marking of Sites) Regulations 1990*

The purpose of these Regulations<sup>11</sup> is to assist the fire authority by the provision of advance and on site information on sites containing large quantities of dangerous substances. The Regulations apply at sites containing total quantities of 25 tonnes or more of dangerous substances. The Regulations include requirements for the erection of suitable signs at access points.

#### 12 *The Planning (Hazardous Substances) Regulations 1992*

These Regulations<sup>25</sup> require that premises at which 50 tonnes or more of nitrocellulose is kept should obtain the appropriate consent for the storage from the relevant Hazardous Substance Authority (HSA). Guidance on these Regulations is contained in the booklet *Hazardous substances consent, a guide for industry*<sup>26</sup> issued by the Department of the Environment and the Welsh Office. In Scotland the Town and Country Planning (Hazardous Substances) Scotland Regulations<sup>27</sup> came into force on 1 May 1993. As these Regulations mirror those for England and Wales the advice contained in the guide to industry may be helpful.

13 *The Notification of Installations Handling Hazardous Substances Regulations 1982*

These Regulations<sup>28</sup> require that premises at which 50 tonnes or more of nitrocellulose is kept should be notified to the Health and Safety Executive (HSE).

14 *The Control of Industrial Major Accident Hazards Regulations 1984 as amended 1989/90*

These Regulations<sup>18</sup> apply at two levels to certain premises where particular quantities of particular substances are stored or used, such as flammable liquids with a flashpoint below 21°C and a boiling point (at normal pressure) above 20°C. The main objective of these Regulations is to prevent major accidents occurring and a secondary objective is to limit the effects of any which do happen. A major accident is a major emission, fire or explosion resulting from uncontrolled developments leading to serious danger to persons or the environment. The first level requirements apply to premises where 5000 tonnes or more of flammable liquids, as defined above, are involved in certain industrial activities, including processing operations and storage. The second level requirements apply where 50 000 tonnes or more of flammable liquids are involved. The general requirements apply at both levels and require a person having control of the industrial activity to demonstrate that he or she has identified the major accident hazards and that the activity is being operated safely. The additional requirements that apply at the second level include the submission of a written safety report, preparation of an on site emergency plan and provision of certain information for the public. HSE booklet HS(R)21<sup>18</sup> gives guidance on these Regulations.

15 *The Fire Precautions Act 1971 (FP Act)*

This Act<sup>29</sup> controls what have come to be known as the 'general fire precautions' including the provision of means of escape, means for fighting fire, means for giving warning in case of fire and the training of staff in fire safety. Responsibility for enforcing the requirements of the FP Act rests with the local fire authority and further guidance is contained in the Home Office publication *Guide to fire precautions in existing places of work that require a fire certificate*<sup>30</sup>. A fire certificate is required under the FP Act in respect of most factory premises and Section 6 of the Act specifies that the fire certificates will contain particulars about any explosive or highly flammable materials which may be stored or used in the premises. Section 8 of the FP Act places an additional statutory duty on occupiers of designated premises to notify the fire authority before any significant changes are made in respect of the type or quantity of explosive or highly flammable materials kept there.

16 *Fire Certificates (Special Premises) Regulations 1976*

These Regulations<sup>31</sup> apply at premises where certain quantities of hazardous materials are stored. Where these Regulations apply, they take the place of the Fire Precautions Act 1961 and designate HSE as the enforcing authority for matters relating to general fire precautions.

## Appendix 2 references

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## Further information

HSE priced and free publications can be viewed online or ordered from [www.hse.gov.uk](http://www.hse.gov.uk) or contact HSE Books, PO Box 1999, Sudbury, Suffolk CO10 2WA Tel: 01787 881165 Fax: 01787 313995. HSE priced publications are also available from bookshops.

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