



for fire safety in  
the storage and  
use of highly  
flammable and  
flammable liquids

Part 1: General principles

**LOSS PREVENTION RECOMMENDATIONS**

The aim of the FPA series of Recommendations is to provide loss prevention guidance for industrial and commercial premises and systems. The series continues a long tradition of providing authoritative guidance on loss prevention issues started by the Fire Offices' Committee (FOC) of the British insurance industry more than a hundred years ago and builds upon earlier publications from the Loss Prevention Council and the Association of British Insurers.

Lists of other publications on loss control including other documents in the RC series are available at [www.thefpa.co.uk](http://www.thefpa.co.uk) and from the FPA at London Road, Moreton-in-Marsh, Gloucestershire GL56 0RH. Copies of publications can be purchased from the FPA at that address or by calling 01608 812500 or e-mailing [sales@thefpa.co.uk](mailto:sales@thefpa.co.uk).

**Technical contact:**

Adair Lewis  
 Fire Protection Association, 3rd Floor, Hampton House,  
 20 Albert Embankment, London SE1 7TJ  
 E-mail: [alewis@thefpa.co.uk](mailto:alewis@thefpa.co.uk)

**IMPORTANT NOTICE**

This document has been developed through the Insurers' Fire Research Strategy Funding Scheme ("InFiReS") and published by the Fire Protection Association ("FPA"). InFiReS membership comprises a group of UK insurers that actively support a number of expert working groups developing and promulgating best practice for the protection of property and business from loss due to fire and other risks. The technical expertise for this document has been provided by the Technical Directorate of the FPA, external consultants, and experts from the insurance industry who together form the various InFiReS Steering Groups. Although produced with insurer input it does not (and is not intended to) represent a pan-insurer perspective. Individual insurance companies will have their own requirements which may be different from or not reflected in the content of this document.

The FPA have made extensive efforts to check the accuracy of the information and advice contained in this document and it is believed to be accurate at the time of printing. However, the FPA make no guarantee, representation or warranty (express or implied) as to the accuracy or completeness of any information or advice contained in this document. All advice and recommendations are presented in good faith on the basis of information, knowledge and technology as at the date of publication of this document.

Without prejudice to the generality of the foregoing, the FPA make no guarantee, representation or warranty (express or implied) that this document considers all systems, equipment and procedures or state of the art technologies current at the date of this document.

Use of or reliance upon this document or any part of its content is voluntary and is at the user's own risk. Anyone considering using or implementing any recommendation or advice within this document should rely on his or her own personal judgement or, as appropriate, seek the advice of a competent professional and rely on that professional's advice. Nothing in this document replaces or excludes (nor is intended to replace or exclude) entirely or in part mandatory and/or legal requirements howsoever arising (including without prejudice to the generality of the foregoing any such requirements for maintaining health and safety in the workplace).

Except to the extent that it is unlawful to exclude any liability, the FPA accept no liability whatsoever for any direct, indirect or consequential loss or damage arising in any way from the publication of this document or any part of it or any use of or reliance placed on the content of this document or any part of it.

**Recommendations for fire safety in the storage and use of highly flammable and flammable liquids**

These recommendations are published in three parts:

Part 1: General principles

Part 2: Storage of flammable liquids in drums, cans and other containers

Part 3: Storage of flammable liquids in external fixed tanks

The documents should be read in conjunction with *LPC Recommendations for the selection of electrical and non-electrical equipment for use in atmospheres containing flammable and explosive gases or vapours* (ref. 1).

**CONTENTS**

Scope	3
Definitions	3
Introduction	3
RECOMMENDATIONS	4
1. General considerations	4
2. Ventilation	5
3. Ignition	5
4. Containment	6
5. Exchange	7
6. Separation	7
7. Electrical equipment for flammable atmospheres	8
8. Transportation in enclosed systems	8
9. Transportation other than in closed systems	9
10. Tanks	9
11. Fire protection	9
12. Fire safety management	9
References	10
Further reading	11

First published by  
 The Fire Protection Association  
 London Road  
 Moreton in Marsh  
 Gloucestershire GL56 0RH  
*Tel: 01608 812500, fax: 01608 812501,*  
*e-mail: [fpa@thefpa.co.uk](mailto:fpa@thefpa.co.uk), website: [www.thefpa.co.uk](http://www.thefpa.co.uk)*

2006 © The Fire Protection Association  
 Copies of this document may be obtained from the publications department of the FPA, at the Moreton-in-Marsh address.

Front cover picture reproduced courtesy of Forensic Science Service Limited.

Printed in Great Britain by Modern Colour Solutions 1.0/05.06

## SCOPE

These recommendations present measures relevant to fire safety in the storage and use of highly flammable and flammable liquids (which may include solvents, adhesives, resins etc) having a flashpoint of up to 55°C. Some of these liquids may represent other types of hazards, for example, to health, but such hazards are not discussed in this document.

The document does not apply to the use or storage of Liquefied Petroleum Gas (LPG), oil firing or spraying, for which more specific guidance is available (see refs 1, 2 and 3).

This advice is not intended to apply to specialised bulk storage tank farms, depots, refineries, petrochemical plants or large chemical works.

Legislation may impose requirements additional to the provisions contained in this document (see refs 4, 5, 6, 7, 8 and 9). Due regard should also be given to considerations of environmental protection.

## DEFINITIONS

### Auto-ignition temperature

The minimum temperature at which a material will ignite spontaneously under specified test conditions.

**Classification of hazardous areas** (BS EN 60079-10: 2003) (This classification refers to areas in which open processes are carried out, areas in which closed processes are undertaken should be subject to a risk assessment.)

**Zone 0:** An area in which an explosive gas atmosphere is present continuously or for long periods.

**Zone 1:** An area in which an explosive gas atmosphere is likely to occur in normal operation.

**Zone 2:** An area in which an explosive gas atmosphere is not likely to occur in normal operation and, if it does occur, is likely to do so only infrequently and will exist for a short period only.

### Explosive limits (BS EN 60079-10: 2003)

**Lower explosive limit (LEL):** The concentration of flammable gas or vapour in air, below which the gas atmosphere is not explosive.

**Upper explosive limit (UEL):** The concentration of flammable gas or vapour in air, above which the gas atmosphere is not explosive

### Flammable liquid

A liquid as defined for highly flammable liquid (see below) but with a flashpoint up to 55°C.

### Flashpoint (BS EN 60079-10: 2003)

The lowest liquid temperature at which, under certain standardised conditions, a liquid gives off vapours in a quantity such as to be capable of forming an ignitable vapour/air mixture.

### Highly flammable liquid

The definition of 'highly flammable liquid' in the Fire Certificates (Special Premises) Regulations 1976 has been amended in DSEAR 2002 as follows:

'Highly Flammable Liquid' means any liquid, liquid solution, emulsion or suspension, other than aqueous ammonia, liquefied flammable gas, and liquefied petroleum gas which:

- (a) when tested in accordance with Part A.9 of the Annex to the Directive has a flashpoint of less than 32°C...;
- (b) when tested at 50°C using the procedure referred to in Appendix B to the 'Approved requirements and test methods for the classification and packaging of dangerous goods for carriage' [ref. 20] with a heating time of 60 seconds supports combustion...

## INTRODUCTION

Flammable and highly flammable liquids fall within the definition of 'dangerous substance' as referred to in the Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) which came into force on 1 July 2003 (ref. 7).

From that date, where a dangerous substance is either present or liable to be present at the workplace, a suitable assessment of the risks likely to arise should be conducted and action taken to eliminate or reduce the hazard. Where an explosive atmosphere may occur the workplace must be classified into zones based on the frequency and duration of the explosive atmosphere and the zones checked by a competent person.

The flashpoint is the property that is conventionally used to classify and indicate the flammability of liquids. Those with flashpoints close to ambient temperatures are obviously more hazardous than those with flashpoints at temperatures unlikely to be reached in the workplace.

Two main dangers need to be recognised:

- (a) the danger of explosion, when flammable vapour/air mixtures fall within their explosive limits;
- (b) the danger of fire, which may involve the flow of burning liquid over a wide area, or the rupture or explosion of unvented or inadequately vented containers.

All flammable liquids, regardless of flashpoint, will contribute greatly to the severity and spread of fire. Physical properties, the auto-ignition temperature, explosive limits, specific gravity, vapour density and oxygen enrichment or depletion of the atmosphere, will need to be considered when specifying risk control measures. Changes of state of a material when heated and the effect of gravity inducing a flow of liquids and vapours also require serious consideration.

The intensity of a fire or its rate of growth may be increased if incompatible materials, such as organic peroxides, are stored adjacent to flammable liquids. In addition, a fire may grow and involve dangerous substances which are themselves not combustible (see Health and Safety booklet HS(G) 71, *Storage of packaged dangerous substances*, ref. 10).

These recommendations apply to all flammable and highly flammable liquids. Under certain conditions some of these requirements, where liquids with high flashpoints are concerned, may be relaxed. The extent of hazard reduction and management will be one of the outcomes of the specific risk assessment conducted in terms of DSEAR and the general fire risk assessment carried out in compliance with current fire safety legislation.

To comply with the requirements of DSEAR, the management of flammable and highly flammable liquids should be subject to a risk assessment undertaken by a competent person. When considering such an assessment it should be remembered that the control measures that may be appropriate in the case of an open process, where flammable vapours are exposed to the atmosphere, may be very different from those which should be observed in an area where a process in which such substances are handled in pipelines and closed containers is undertaken.

The risk assessment is not a once in a lifetime approach. It should be reviewed periodically and when there are changes in:

- the equipment being used
- the materials being used in the process
- the operating procedures
- the operating parameters and control measures that are observed
- the management of the process
- the size of the operation
- the process times involved.

The risk assessment should also be reviewed following an incident or near miss.

Specialist advice should be sought where materials, such as organic peroxides and monomers, are in use that present not only flammability, but also other special hazards.

The main causes of fire involving flammable liquids, which should be borne in mind when carrying out the risk assessment, include:

- lack of awareness: incorrect/improper installation or use of equipment; hazardous situations not being recognised; or people being ignorant of the hazards associated with flammable liquids.
- lack of maintenance: where no problem areas are apparent (such as in the case of a closed process) and it is felt that the cost of regular maintenance is not justified.

- blatant misuse: poor management procedures where a person engages in an unsuitable or prohibited practice (for example, smoking) with total disregard for safety regulations.
- carelessness: where an existing problem is recognised but ignored.
- improper design: possibly by a person not qualified to do so and ignoring relevant legislation and/or standards.
- static electricity: where movement of flammable liquid in the handling process may lead to a build up of charge.
- absence of good housekeeping: where areas are not kept free from other combustible materials.
- lack of management of 'empty' containers: for example, where containers used in large scale operations have been decommissioned but subsequently inadvertent steam injection has raised the temperature inside a container high enough to reach the autoignition temperature of the residual deposits.

In addition to the DSEAR, the requirements of the Control of Pollution (Oil Storage) (England) Regulations 2001 (ref. 9) should be observed, particularly those relating to the provision of bunds around storage tanks.

## RECOMMENDATIONS

### 1 General considerations

- 1.1 At the outset, attention should always be given to eliminating flammable and highly flammable liquids from the workplace wherever possible., Serious consideration should be given to the need for the use of such liquids in the process and the possibility of replacing them with non-combustible liquids alternatives - or at least with those having a flashpoint above 55°C
- 1.2 The HSE guidance in booklet HS(G)51 (ref. 11) suggests the use of the acronym VICES to help apply five basic principles which ensure that any flammable or highly flammable liquid that is irreplaceable is used and stored with appropriate care.

The acronym may be explained as follows:

#### *V Ventilation* (see section 2)

- Is there sufficient ventilation to keep the concentration of the liquid's vapour below its lower explosive limit?

#### *I Ignition* (see section 3)

- Have all possible ignition sources been removed?
- Is the electrical equipment used in this area suited to the risk category?

**C Containment** (see section 4)

- Are the liquids stored in suitable containers?
- In the event of a spill will they be contained?
- Is it possible to prevent spillages from spreading?
- Are bunds or catchment trays present where required?
- Are 'empty' containers properly managed?

**E Exchange** (see section 5)

- Can flammable substances be eliminated?
- Can the substance be replaced by a less flammable one?

**S Separation** (see section 6)

- Is the storage of liquids separated from other stored materials?
- Are incompatible materials suitably separated?
- Are physical barriers (examples might be walls, doors, cabinets and bins) present as required?

1.3 Suitable staff training should be in place to ensure all personnel are aware of the hazards in the workplace and apply VICES to ensure a safer working environment for all.

**2 Ventilation**

2.1 Flammable liquid stores should be at or above ground level unless sufficient mechanical ventilation is provided.

2.2 Safe procedures should be followed for the cleaning of tanks and vessels, particularly where a change of use or type of content is proposed (see HSE Guidance Note CS15, ref. 12).

2.3 Adequate ventilation should be provided by natural or mechanical means to prevent the concentration of vapour accumulating to within the relevant explosive limits of the liquid(s) in use. The degree of ventilation required will depend on the flashpoint of the liquid, the quantities used, the location of the work and the type of process in use and will normally be determined by reference to the COSHH assessment (see ref. 5).

2.4 Ventilation openings should be provided at low and high level, direct from the storage area to the outside, to prevent the accumulation of flammable vapour. Care should be taken to prevent drums and other items from obstructing the openings.

2.5 Ventilation may be achieved by the use of air-bricks. Alternatively, mechanical ventilation may be used, providing at least six air changes per hour. Extract must be at low level and the inlet at high

level, positioned so as to provide cross-flow. Duct openings should not allow fire spread. Fan motors should not be positioned within ductwork, and should be suitable for the hazard zone. All mechanical ventilation installations shall comply with BS 5925 (ref. 13).

2.6 Where mechanical ventilation is installed the location of the exhaust outlet should be subject to a risk assessment in compliance with DSEAR. Ducting should:

- be of non-combustible construction,
- take as short a route as possible,
- have as few directional changes as possible,
- be arranged so that vapours cannot condense and collect at low points in the ductwork, and
- be routed to a safe place in the open air.

2.7 In most cases it should be adequate if the ventilation ductwork is terminated at least 3m above ground level and the same distance from building openings (including the eaves of buildings), boundaries and sources of ignition.

2.8 Where flammable or highly flammable liquids are stored and no mechanical ventilation is provided, explosion relief should be provided according to the findings of a risk assessment. In such a case, a lightweight roof or relief panels in the walls would serve to vent an explosion, provided that they release the pressure to a safe place so as not to cause injury or damage to property.

2.9 The discharge of dangerous substances into the atmosphere may have an environmental impact and thus expert advice should be sought where necessary.

**3. Ignition**

3.1 One of the major objectives of any fire risk assessment is to identify potential sources of ignition in the workplace. These will include flames, hot surfaces and areas of movement that may lead to the generation of heat by friction or the build up of static charges. All potential sources of ignition should be maintained well below the autoignition temperature of the liquid.

3.2 Assessment of the lightning risk should be undertaken in accordance with BS 6651 (ref. 14), the Draft IEC 62305 suite of documents (refs 15, 16) or similar recognised guidance (ref. 17). In the petrochemical industry a specific strategy is used that is outside the scope of this document. Particular consideration is warranted for buildings and tanks in the open containing flammable liquids.

3.3 Smoking must be prohibited in all areas where flammable liquids are used or stored and suitable notices prominently displayed.

- 3.4 All maintenance or contractors' work should be carried out according to a Method Statement (provided by the contractor or the site occupier as necessary) and under a 'Permit to Work' system. Special precautions are necessary when work may generate heat or sparks and strict safety procedures must be followed in respect of any work involving plant or equipment containing, or used for the handling of flammable liquids (see *LPC Recommendations for hot work*, ref. 18). The measurement of vapour concentrations might be required in areas where the liquids cannot be safely removed or where it is suspected that high concentrations still exist, to ensure that the concentration is below the product's lower explosive limit (LEL).
- 3.5 Where possible, cold cutting should be used as an alternative to hot work or the equipment should be removed to a safe environment, such as a workshop, for the work to be conducted.

### **Heating**

- 3.6 Heating must be suitable for the zone in which the work is being carried out (see Definitions section of this document). Areas used for the storage and use of highly flammable and flammable liquids may be heated by the following:
- 3.6.1 A heating system providing ducted warm air or supplying hot water or steam to pipes and radiators. The system should incorporate a heat exchanger so as to prevent flammable vapours from coming into contact with an ignition source.

Any furnace or heat exchanger should be segregated and located either outside the Zone or in a separate building of brick or concrete construction with a self-closing door to each opening. Combustion products should be exhausted to the open, clear of windows or other openings of the zone in which the highly flammable or flammable liquids are being stored or processed.

Hot water or steam should circulate at a temperature not exceeding 120°C.

- 3.6.2 Electrical heaters of the low temperature flameproof type, certificated for the use. The temperature of the external surface of such heaters should not exceed 120°C.
- 3.6.3 Electrical underfloor or ceiling heating with heating elements totally embedded in concrete.

### **Static electricity**

- 3.7 The potential hazard of ignition due to a build-up of static electricity should be assessed and precautions taken to eliminate it. See section 4.1 and ref. 19.
- 3.8 Where high concentrations of vapours are present the use of synthetic clothing and non-conducting shoes should be avoided to prevent a build-up of static electricity and possible discharge.
- 3.9 All plant and equipment used for handling highly flammable liquids must be electrically bonded and earthed (see ref. 19); non-static tools should also be used. Consideration should be given to any additional measures necessary to prevent the build up and uncontrolled discharge of static electricity.
- 3.10 Where decanting takes place into a container with a smaller opening, a funnel should be used. Where a hose is used it should be ensured that the hose is of a conducting type.
- 3.11 Filling lines should terminate as close as possible to the bottom of tanks/containers to reduce the likelihood of a static build-up and discharge.
- 3.12 (a) Safety drum transfer pumps incorporating controlled flow dispensing valves, flame arresters, self-closing lids and suitable earth bonding arrangements should be used for transferring larger volumes of liquids. Drip trays should be provided.
- (b) Smaller volumes of highly flammable liquids should be handled using safety dispensing cans (see ref. 20).

### **Fork-lift trucks**

- 3.13 Only lift trucks certificated to the appropriate electrical zoning standard should be used (see HSE Guidance HS(G) 113, ref. 21).
- 3.14 Gangways should be sufficiently wide to permit safe manoeuvring of trucks.
- 3.15 Battery powered trucks should not be charged within a zone in which a hazardous atmosphere may be present.
- 3.16 The gas cylinders of LPG fuelled trucks should not be changed in areas where highly flammable or flammable liquids are stored or used.
- 3.17 Further guidance on the safe use of fork-lift trucks can be found in RC11, *Recommendations for the use of fork-lift trucks* (ref. 22).

## **4. Containment**

- 4.1 Topographical features of the premises and surrounding area should be taken into account when considering the choice of locations for the storage or use of flammable liquids. In all cases the implications of undulations should be considered in relation to a possible release of the materials that are being handled or stored. The potential consequences of fire water run-off should be taken into account. (See HSE Guidance Note EH 70, ref. 23.)

- 4.2 Safe catchment areas need to be provided to contain a possible flowing liquid fire and to guard against the risk of pollution.
- these catchment areas, or bunds, must have a capacity of not less than 110% of the capacity of the largest container in the bund or 25% of their aggregate storage capacity, whichever is greater
  - the base and walls of the bund must be impermeable to oil and water
  - the base and walls must not be penetrated by any drain pipe, valve or opening
  - if any fill or draw off pipe passes through the base or wall of the bund the junction between the pipe and the base or wall must be adequately sealed to prevent the escape of oil or water
  - tanks and bunds must be positioned so as to minimise the risk of damage by impact as far as practicable
- 4.3 Adequate drainage facilities should be provided, to a suitable container or a safe place. Discharge to main drains should not be permitted. Care should also be taken to prevent dense flammable vapours from entering drains.
- 4.4 Flammable and highly flammable liquids should not be stored or handled in areas that are liable to flooding.
- 4.5 Operating procedures should ensure that before transfer operations commence, a check is made to confirm that the liquid or solvent being delivered is of the correct type and that the quantity can be accommodated within the vessel.
- 4.6 Automatic shut-offs incorporating overfill alarms should be fitted to all enclosed vessels and to all vessels supplied by piped services, as a precaution against overfilling.
- 4.7 Containers should not be punctured to open them.
- 4.8 Where there is tank storage within a building, consideration should be given to providing an emergency dump facility.
- 4.9 It is desirable to provide a means of spill control, such as floor dishing or ramped sills, at door openings between compartments.
- 4.10 Spillages can happen at any time. An assessment should be made of the possible location and size of spillage or leakage and an action plan drawn up to include the availability of appropriate non-combustible absorbent materials and tools to deal with any incident.
- 4.11 Containers which appear to be empty may contain residual vapour and can be extremely hazardous. They should be kept securely closed and treated in the same way as full containers.

## 5. Exchange

Although it is the fourth letter of the acronym 'VICES', exchange refers to the primary need to ensure that flammable and highly flammable liquids are eliminated from the workplace if at all possible. Each such liquid should be considered in turn and possible non-combustible or aqueous alternatives be considered. (A successful example of the practical application of this principle is to be found in the printing industry, where flammable blanket wash has largely been replaced by suitable water-based alternatives.)

## 6. Separation

- 6.1 Wherever flammable liquids are stored or used, a list of the substances present should be maintained, along with details of their quantities and location (see COSHH Regulations, ref. 5). The list should be kept in a place where it is readily available for use by the fire brigade, such as a gatehouse.
- 6.2 Flammable liquids should not be stored with oxidising agents or flammable gases. Oxidising agents or other products incompatible with flammable liquids should be stored in separate areas.
- 6.3 If practicable, the processing or handling of flammable liquids should be carried out in a detached building or, where this is not practical, in a compartment providing at least two hours fire resistance. (See *LPC Design Guide for the Fire Protection of Buildings 2000*, ref. 24.)
- 6.4 Where flammable liquids are handled or stored, attention should be paid to the provision of appropriate physical barriers, such as compartment walls, floors and doors, to restrict the flow of a spillage and also to suitable cabinets or bins.
- 6.5 High standards of housekeeping should be maintained to prevent the accumulation of rubbish, particularly combustible materials, in the vicinity of flammable and highly flammable liquids:
- any waste materials, contaminated cleaning rags etc, should be stored in clearly marked metal bins with metal lids and removed to a safe external area at the end of each shift or working day.
  - waste flammable liquids should not be mixed and should be kept in clearly marked, closed, waste disposal tanks. The storage of waste flammable liquids should be to the same high safety standard as for virgin flammable liquids.
  - waste materials must not be disposed of by burning.

- waste flammable liquids should be disposed of carefully on-site and where necessary removed from site for further treatment by suitably experienced waste contractors.

For further guidance see the FPA's book *Fire safety and waste materials* (ref. 25).

6.6 Quantities of flammable liquids held in any working area should be kept to a minimum and be subject to a process risk assessment. In all cases the volumes should not exceed the requirements for the day or shift being worked. The risk assessment must ensure that less than 50l of highly flammable liquid or 250l of flammable liquid are kept in the working area at any time.

6.7 Materials in the work area but not actually in use should be kept in closed containers within suitable lockers.

## 7. Electrical equipment for flammable atmospheres

7.1 When highly flammable liquids are present, although control measures are taken to minimise their uncontrolled release as far as is reasonably practicable, there will always remain the possibility of an explosive/flammable atmosphere occurring. In such 'hazardous areas' all sources of ignition, including those associated with electrical sparks or hot surfaces of electrical apparatus, should be excluded or protected. Hazardous areas are classified into zones as described in the Definitions section of this document.

7.2 An assessment of the work areas and storage areas should be carried out and appropriate 'zones' assigned in accordance with the Dangerous Substances and Explosive Atmospheres Regulations 2002 and BS EN 60079-10 (ref. 26).

7.3 Should it be necessary to use electrical apparatus or install wiring in hazardous areas it is imperative that it is suitable for use in a flammable atmosphere. Expert advice may need to be sought for this assessment, because enclosed processes may produce different zoning risk assessments from when the same flammable liquids are in use in open areas. In the former case they have a reduced exposure probability. Certified explosion-protected electrical apparatus and cabling appropriate for the relevant zones should then be selected. All electrical equipment used in these areas shall comply with BS EN 60079-10: 1996 or equivalent.

(Also see *Recommendations for the selection of electrical and non-electrical equipment for use in atmospheres containing flammable and explosive gases or vapours*, ref. 27.)

7.4 It is recommended that a plan be prepared to identify the appropriate zones and that this be displayed prominently in order to help ensure that

all staff, contractors and visitors are aware of the appropriate zone and that no unauthorised activities take place in these areas.

## 8. Transportation in enclosed systems

8.1 In piped systems flammable liquids should be supplied by metered pumps and not be gravity fed.

8.2 Pumps should be appropriately rated for the zone in which they are installed (see 7.2 and 7.3).

8.3 Pipes should normally be of steel or stainless steel or approved by recognised standards. They should be clearly labelled and/or colour coded, be marked with arrows to indicate the direction of flow and with any additional marking to indicate a hazard as necessary. The marking should especially be done near to the most hazardous points such as joints or valves.

8.4 The imposed loads should be taken into account when pipes are buried and appropriate measures, including installation on a bedding of compacted material, and covering suitably, should be taken to protect such pipes. Two or more levels of pipes in a single trench should be separated vertically by at least 150mm of well compacted backfill.

8.5 Similarly, loads should be considered when designing support systems for pipelines above ground level.

8.6 The system should be electrically bonded and earthed (see ref. 19).

8.7 Quick-action shut-off valves should be provided at the dispensing point, to guard against spillage.

8.8 In addition to local shut-off valves, to ensure that under fire conditions supplies are isolated in the most effective manner, emergency stops should be provided to turn off pumps and to close valves installed at the most remote point, ideally at the source of the supplies.

8.9 Consideration should be given to interlocking the emergency stops to operate automatically in the event of any alarm arising from the operation of manual or automatic fire alarm systems and sprinklers. In addition, the pumps should be isolated and the remotely located valves closed out of working hours.

8.10 No pipe carrying flammable or highly flammable liquid should pass through any ducting or hazardous areas such as transformer rooms where it could be exposed to excessive heat or corrosion.

8.11 Pipe runs should be kept as short as possible with directional changes kept to a minimum.

8.12 Flexible pipes can be used in areas of vibration. These should be designed so that the possibility of the diameter of the pipe being restricted by kinking

or a similar process is avoided. Flexible pipes should be kept as short as possible and should be electrically bonded and pressure tested annually.

- 8.13 Where practicable, welded joints are preferred over flanges to reduce the possibility of leaks. Where welding is not practical, pipes should be flanged, threaded or mechanically attached so that the mechanical strength of the joint will not be impaired if exposed to fire.
- 8.14 Piping systems used for transporting flammable or highly flammable liquids should be maintained liquid tight. Pipework that leaks constitutes a hazard and should be emptied of liquid and repaired in a suitable manner.

## 9. Transportation other than in closed systems

- 9.1 Wherever large quantities of flammable or highly flammable liquids have to be routinely handled, consideration should be given to transporting the material via a pipeline.
- 9.2 Pipelines should be colour coded (ref. 28), and be marked with arrows to indicate the direction of flow and with any additional marking to indicate a hazard, as necessary. The emergency cut off valves should also be clearly signed.
- 9.3 Small quantities of flammable and highly flammable liquids should always be transported in safety containers; open containers should never be permitted to be used for this purpose.
- 9.4 Containers should be of robust construction so as to resist damage during transit.

## 10. Tanks

- 10.1 Any tank heating equipment should be fitted with a duplicate thermostat and high temperature limit device. The high temperature limit device should prevent the temperature of the liquid exceeding a temperature of 10°C below its boiling point. There should be a regular testing programme for the thermostats and temperature limit devices, with the results being recorded.
- 10.2 Any vessel containing internal heating elements should be fitted with a duplicate low-liquid-level alarm and cut-out to prevent the elements being exposed to the atmosphere. Provision should be made for isolation of the system in the event of an emergency.
- 10.3 Vent pipes from storage tanks should be designed to release vapours so as to allow them to disperse safely; this should be subject to a risk assessment in compliance with DSEAR. Normally, a discharge height of 0.3m above the top of the tank or at least 3m above ground level should be sufficient but there may be a need to increase this height to achieve effective and safe vapour

dispersion. Vent outlets should be located so that vapours are discharged upwards or horizontally away from adjacent walls and clear of eaves and other obstructions.

- 10.4 All tanks and vessels should be clearly and boldly marked in accordance with the Health and Safety (Safety Signs and Signals) Regulations 1996 (ref. 8) or other applicable legislation as listed in Schedule 5 of DSEAR.
- 10.5 Details of precautions regarding the storage of flammable liquids in external fixed tanks are set out in RC20 Part C (see ref. 35).

## 11. Fire protection

- 11.1 Where flammable liquids are used or stored, appropriate portable fire extinguishers, approved and certificated by an independent, third-party certification body, should be installed and maintained in accordance with British Standard BS 5306: Parts 3 and 8 (see refs 29 and 30).
- 11.2 Consideration should be given to installing a fixed firefighting system, such as sprinklers with foam additives. This will be particularly relevant for very hazardous plant or processes that are critical to the wellbeing of the business. When installing such a system the guidance set out in Technical Bulletin TB214 should be followed in addition to that in BS EN 12845 (refs 31 and 32).
- 11.3 Consideration should also be given to installing an automatic fire detection and alarm system to comply with BS 5839: Part 1 (ref. 33).
- 11.4 In zoned hazardous areas, it may be necessary for fire detection systems and communications systems to be intrinsically safe and appropriate for the zone, temperature and other relevant parameters.

## 12. Fire safety management

- 12.1 A training scheme should be established and monitored for the training and refresher training of people who are using or could be using flammable liquids.
- 12.2 The workforce should be made aware of the presence and use of flammable liquids, and the hazards involved within the buildings in which they are working.
- 12.3 Staff should be trained in good practice relating to the opening, handling and disposal of containers (for example, containers should be opened correctly rather than punctured).
- 12.4 All staff should be familiar with the hazards associated with the product(s) used, the necessary precautions and the action to be followed in the event of fire or spillage. These include how to:

- raise the alarm
  - ensure all staff evacuate
  - call the fire brigade
  - attack the fire if it is safe to do so
  - contain spillage and dispose of the used materials safely
  - ventilate (open windows, doors and other openings intended for this purpose to increase ventilation).
- 12.5 Staff should be made aware of the hazards of deliberate fire raising, which may be carried out by both colleagues and intruders.
- 12.6 Flammable liquids and ‘empty’ containers should not be accessible to intruders; suitable security measures should be in place.
- 12.7 Containers should be labelled in accordance with BS 5378 (see ref. 34).
- 12.8 Electrical equipment, including electric lighting, provided or installed, should be appropriate for the zone (assessed according to BS EN 60079-10) in which it is to be used. In areas where unenclosed liquids are being used and zones have not been defined, measures should be taken as would be appropriate when considering the whole area as an area of highest hazard (i.e. zone 0).

## References

1. *Recommendations for the storage, use and handling of common industrial gases in cylinders including LPG*, RC 8, Fire Protection Association, 2005.
2. *Recommendations for oil fired installations*, RC 9, Loss Prevention Council, 1990.
3. *Recommendations for spraying and other painting processes involving flammable liquids and powders*, RC 14, Loss Prevention Council, 1989.
4. The Petroleum (Consolidation) Act, 1928.
5. The Control of Substances Hazardous to Health Regulations 2002, SI 2002/2677 (as amended).
6. Chemicals (Hazard Information and Packaging for Supply) Regulations 2002, SI 2002/1689.
7. Dangerous Substances and Explosive Atmospheres Regulations 2002, SI 2002/2776.
8. The Health and Safety (Safety Signs and Signals) Regulations 1996, SI 1996/341.
9. Control of Pollution (Oil Storage) (England) Regulations 2001, SI 2001/2954
10. Health and safety booklet HS(G) 71: *Storage of packaged dangerous substances*, Health and Safety Executive, 1998.
11. Health and safety booklet HS(G) 51: *Storage of flammable liquids in containers*, Health and Safety Executive, 1998.
12. Health and safety guidance note: *The cleaning and gas freeing of tanks containing flammable residues*, CS15. Health and Safety Executive. 1985.
13. British Standard 5925: 1991: *Code of practice for ventilation principles and designing for natural ventilation*, British Standards Institution.
14. British Standard 6651: 1992: *Code of practice for protection of structures against lightning*, British Standards Institution.
15. Draft IEC 62305-2 *Protection against lightning: Risk management*, British Standards Institution, 2003.
16. Draft IEC 62305-3, *Protection against lightning: Physical damage to structures and life hazard*, British Standards Institution, 2003.
17. *Recommendations for the protection of buildings against lightning strike*, RC 35, Fire Protection Association, 2005.
18. *Recommendations for hot work*, RC 7, Fire Protection Association 2001.
19. British Standard 7430: 1991: *Code of practice for earthing*, British Standards Institution.
20. *Fire Safety: an Employer’s Guide*, Health and Safety Executive, 1999.

21. Heath and safety booklet HS(G) 113: *Lift trucks in potentially flammable atmospheres*, Health and Safety Executive, 1996.
22. *Recommendations for the use of fork-lift trucks*, RC 11, Fire Protection Association, 2005.
23. HSE Guidance Note EH 70: *The control of fire-water run-off from CIMAH sites to prevent environmental damage*, Health and Safety Executive, 1995.
24. *LPC Design Guide for the Fire Protection of Buildings 2000*, Fire Protection Association, 1999.
25. *Fire Safety and Waste Materials*, Adair Lewis, Fire Protection Association, 2003.
26. British Standard EN 60079: *Electrical apparatus for explosive gas atmospheres: Part 10: 2003: Classification of hazardous atmospheres*, British Standards Institution.
27. *Recommendations for the selection of electrical and non-electrical equipment for use in atmospheres containing flammable and explosive gases or vapours*, RC 30, Fire Protection Association 2005.
28. British Standard 1710: *Identification of pipelines and services*, British Standards Institution, 1984 (1991).
29. British Standard 5306: *Fire extinguishing installations and equipment on premises: Part 3: 2000: Code of practice for the inspection and maintenance of portable fire extinguishers*, British Standards Institution.
30. British Standard 5306: *Fire extinguishing installations and equipment on premises: Part 8: 2000: Selection and installation of portable fire extinguishers – Code of practice*, British Standards Institution.
31. British Standard/European Standard 12845: 2003: *Fixed firefighting systems – Automatic sprinkler systems – Design, installation and maintenance*, British Standards Institution.
32. *LPC Rules for Automatic Sprinkler Installations*, Technical Bulletin 214: 2003. Sprinkler protection of flammable liquid stores, Fire Protection Association.
33. British Standard 5839: *Fire detection and fire alarm systems for buildings: Part 1: 2002: Code of practice for system design, installation, commissioning and maintenance*, British Standards Institution.
34. British Standard 5378: *Safety signs and colours: Part 1: 1980: Specification for colour and design*, British Standards Institution.
35. *Recommendations for the storage of flammable liquids in external fixed tanks*, RC20 Part C, Loss Prevention Council, 1997.

### Further reading

Heath and safety booklet HS(G) 140, *Safe handling of flammable liquids*, Health and Safety Executive.

Chemical Safety Guidance Note CS24: *The interpretation and use of flashpoint information*, Health and Safety Executive, 1999.

*Unloading petrol from road tankers. Dangerous Substances and Explosive Atmospheres Regulations 2002*, Approved Code of Practice and Guidance L133, HSE Books, 2003.

*Design of plant, equipment and workplaces. Dangerous Substances and Explosive Atmospheres Regulations 2002*, Approved Code of Practice and Guidance L134, HSE Books, 2003.

*Storage of dangerous substances. Dangerous Substances and Explosive Atmospheres Regulations 2002*, Approved Code of Practice and Guidance L135, HSE Books, 2003.

*Control and mitigation measures. Dangerous Substances and Explosive Atmospheres Regulations 2002*, Approved Code of Practice and Guidance L136, HSE Books, 2003.

*Safe maintenance, repair and cleaning procedures. Dangerous Substances and Explosive Atmospheres Regulations 2002*, Approved Code of Practice and Guidance L137, HSE Books, 2003.

*Dangerous Substances and Explosive Atmospheres. Dangerous Substances and Explosive Atmospheres Regulations 2002*, Approved Code of Practice and Guidance L138, HSE Books, 2003.

*Recommendations for the storage of flammable liquids in drums, cans and other containers*, RC20 Part B, Loss Prevention Council, 1997.

RC20  
Part 1

for fire safety in  
the storage and  
use of highly  
flammable and  
flammable liquids

Part 1: General principles



InFiReS

Recommendations