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Guidance for the storage of liquids in intermediate bulk containers

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Chemical Business Association

Solvents Industry Association
Chemical solutions. Common responsibility.

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This Guidance is not an authoritative interpretation of the Law, but if you do follow the Guidance, you will normally be doing enough to comply with the Law. Similarly, Health and Safety Inspectors seeking to secure compliance with the Law may refer to this Guidance as illustrating good practice.

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This guidance has been prepared by the Chemical Business Association and the Solvent Industry Association in consultation with the Health and Safety Executive.

This guidance should not be regarded as an authoritative interpretation of the law, but if you follow the advice set out in it you will normally be doing enough to comply with health and safety law in respect of those specific issues on which the guidance gives advice.

Intermediate Bulk Containers (IBCs) are implicated in many incidents, such as stack collapse, leakage of contents, and serious fires. High standards in their use are an important aspect of risk management.

The HSE believes that the contents of this guidance set out good practice for the chemical industry (including distribution and storage), and commends its use. HSE inspectors will refer to the guidance in assessing site standards.

CONTENTS

	Page
Introduction	5
The problem	6
Legal duties	6
Risk assessment	7
Intermediate Bulk Containers	8
Hazards of substances	9
Fire Vulnerability to Fire Other hazards	
Risk management	13
Controls Packaging Segregation Storage area Racking and stacking Operations Emergency procedures and equipment	
Information and training	17
Site security	17
Glossary	18
References	20
Guidance	21

Introduction

1. This guidance provides information on the hazards associated with the storage of liquids in Intermediate Bulk Containers (IBCs). It sets out practical measures on the design, construction, operation and maintenance of storage areas and buildings used for storing packaged liquids. These measures are designed to protect people at work and others who may be affected by the storage of packaged liquids. The scope of this guidance document has intentionally been limited to the UK land-based storage of liquids in IBCs. This guidance is not intended to cover in detail the hazards associated with filling and emptying IBCs, though some of those hazards are mentioned

2. The guidance is aimed at those directly responsible for the safe storage of such IBCs in all general work activities.

3. Organisations, safety specialists and trade organisations may wish to use this guidance as a basis for more specific advice or training for their staff, clients and members.

4. This guidance should not be used in isolation. It makes reference to other documents and they should be consulted wherever appropriate. British Standards and other documents mentioned in this guidance are regularly updated and the reader should ensure that the most recent revision is consulted.

5. The objectives of this guidance are to:

    - Increase the awareness of the dangers associated with the storage of packaged liquids; and especially in IBCs

    - Help in the assessment and reduction of the risks associated with the storage of packaged liquids in IBCs

    - Advise on safe management procedures and precautions to reduce injuries and damage caused by incidents involving the storage of packaged liquids. Health is also important, but it is not addressed specifically in this document

    - Give guidance on the appropriate standards for the design and construction of storage areas and buildings used for storing packaged liquids at ambient temperature and pressure

    - Advise on the need for appropriate precautions, maintenance, training and good housekeeping where packaged liquids are stored

The problem

6. IBCs have become very widely used, not just in transport for which they were originally designed, but also for longer-term storage, and in some cases for waste disposal and other activities.

7. Investigations after a number of fires have shown that IBCs have particular vulnerabilities.

8. The Health & Safety Laboratory (HSL) has carried out research work[1], which has shown that plastic IBCs (and others with plastic fittings) when exposed to comparatively minor fires may release their contents relatively easily. Most plastic or composite IBCs have exposed plastic components that are not in good thermal contact with the liquid; valves, secondary closure caps, corner protection and "doghouse" flaps are common examples. These components are susceptible to ignition by brief exposure to flames, even if these flames are as small and transient as those from a match. This makes IBCs vulnerable to ignition by grass fires, small-ignited spillages, minor acts of arson, etc. Such ignitions typically develop fairly rapidly to cause complete failure of the IBC and involvement of the contents.

9. Plastic or composite IBC's containing non-aqueous liquids typically fail rapidly when exposed to an engulfing fire. After failure, IBCs release their contents in a few tens of seconds and spreading of the liquid released can lead to rapid involvement of more containers. Where the liquids are combustible large volumes of free burning liquid may be produced and fire may spread very rapidly.

10. The outcomes of that research have been reflected in this guidance.

Legal duties

11. Legal duties arise from many sources, and the references contain a number of the most relevant. For the purpose of this guidance those duties may be summarised as requiring safety to be actively managed through a process that starts with risk assessment. Risk assessment in turn starts with a recognition of the hazards presented by any process, identifying who or what (e.g. the environment) may be affected, and to what extent, and putting in controls that are adequate to eliminate or minimise those risks.

12. The guidance and reference sections list the most relevant legislation

Risk assessment

13. Risk assessment is the systematic evaluation of work activities using the following five steps:

Step 1: Identify the hazards.
Step 2: Identify the exposures. Who and what could be harmed and how?
Step 3: Evaluate the risks arising. Decide whether existing precautions are adequate or if more should be done.
Step 4: Record the findings.
Step 5: Review the assessment regularly and revise if necessary.

14. Advice on carrying out risk assessments is contained in an HSE Guidance leaflet INDG163 [2].

15. The remaining sections of this guidance help to identify many of the hazards associated with the storage of liquids in IBCs, and give guidance on how to reduce the risks. The assessor must ensure that all relevant local factors are taken into account.

16. It is important to set out the limitations of the risk assessment. A complete risk assessment will also have to consider other hazards, which are not within the scope of this guidance. The responsibility for ensuring a suitable and sufficient risk assessment is carried out remains with the employer (usually the site operator).

17. The risk assessment should consider adjacent storage, including storage in other forms of packaging and/or bulk, as well as other classes of dangerous goods and low hazard goods.

18. Where an employer has five or more employees the significant findings of the risk assessment should be recorded. Further guidance can be found in HSE guidance L21 Management of Health and Safety at Work Regulations 1999 (MHSW) [3].

19. HSG71[4] gives guidance on the storage and segregation of dangerous substances. For flammable liquids the basic advice is to store them in a cool dry place away from sources of ignition and heat. It adds that it is preferable for the store to be in the open air. Specific advice in relation to flammable liquids in containers is in HSG51[5]. The SIA/CBA have produced specific member guidance for the storage of flammable liquids in “sealed packages” in specified external storage areas[6].

20. This guidance provides advice on the factors that need to be taken into account with special reference to IBCs and on the actions needed to reduce the occurrence and effects of fire involving them.

21. HSG51[5] recommends that storage areas for flammable liquids be normally classified as Zone 2 hazardous areas (see Appendix 3 in HSG51 for definition of hazardous areas). However, it is incumbent on site operators, under Regulations 5 and 7 of the *Dangerous Substances and Explosive Atmospheres Regulations 2002* [7] (DSEAR) to carry out their own specific site risk assessment and to determine the extent and types of hazardous areas that may exist on their premises. CBA and SIA offer joint guidance to members on the operation of materials handling equipment in areas not formally zoned under DSEAR[16]

Intermediate Bulk Containers (IBC)

22. IBCs are a form of "packaging" and were originally designed for the carriage, often internationally, of dangerous goods, mostly liquids. They are subject to internationally agreed certification procedures, the details of which may be found in, for example, the European Agreement, which regulates the carriage of dangerous goods by road (ADR[17]). The process is known as "UN certification"

23. The relevant parts of the definition of IBC are set out in the glossary.

24. The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2007 [8] (CDG 2007) largely implement ADR[17] in GB (with analogous provisions for Northern Ireland).

25. Various UN certified IBC's are available. In the context of flammable liquids, these can be sub-divided into three main types:

All metal e.g. Stainless Steel/Mild Steel/Aluminium	 
All plastic	
Composite (usually plastic with a wire or tubular frame)	 

26. The UN certification procedure does not provide for control of static charge, but some plastic IBCs have a conducting outer layer or metallic "jacket" intended to allow earthing for static control.

27. This guidance on storage does not include bowsers for which a separate risk assessment should be undertaken.

Hazards of substances

28. CDG 2007[8] and ADR[17] will be the primary basis used to identify material hazards in this guidance. Note that classifications according to the "supply" legislation (CHIP) [9] are used in determining the status of a site under the Control of Major Accidents and Hazards Regulations (COMAH) 1999[10], as amended. Supply classifications are also likely to be important in the context of health hazards to those who may come into contact with substances

29. For the purposes of this guidance the hazard classes of liquids in IBCs are:

Highly Flammable and Flammable Liquids	
Oxidising Liquids	
Toxic Liquids	
Corrosive Liquids	
Liquids Dangerous to the Environment	

30. Liquids, which are "combustible", but not "flammable" (i.e. those with a flash point above 60° C) are not classified as dangerous for transport but should be included in any risk assessment. Examples include many edible oils, essential oils and lubricating oils. Note that gas oil and diesel (UN1202) are classified as flammable up to flash point 100° C.

31. Flammable Liquids covered by this guidance are of those of Packing Groups II and III.

    Under ADR[17] 2007 these are classified according to the following specifications:

Initial Boiling point:	Greater than +35° C
Flash point range:	Not more than +60° C
Vapour Pressure:	Not more than 300kPa (3 bar) at 50° C

32. Liquids of Packing Group I cannot legally be transported in IBCs, but if so stored the site operator should ensure that the risk assessment is especially robust.

Fire

33. The most obvious hazard to be considered is flammability. Substances vary in flammability and this is usually measured by flashpoint (FP). The lower the flashpoint the greater the hazard. Liquids with FP below about 30^{o} C present the greatest hazards as they can create flammable atmospheres at most ambient temperatures.
34. Other properties to consider in this context include miscibility with water, as this will affect fire-fighting procedures.
35. The most important objective is to ensure that containment is not breached and most controls will be aimed at this outcome. Consideration will have to be given to, for example

IBCs	• The right sort for the substance, e.g. is its UN certification valid? Is the material of construction resistant to the contents, possibly for long periods? • In good condition? • Stacked within their limitations for loading and compatibility? • Vulnerability to fire?
Mechanical handling	• Mechanical handling equipment operated properly? • Equipment properly maintained? • Equipment specified correctly for the “DSEAR zoning”?
Racking	• Adequate strength? • In good condition and stable?
Floor /ground surfaces	• Flat? - Especially if IBCs are stacked • In good condition to ensure IBCs are stable? • Free of “puncture risk”? (especially where plastic IBCs are used)

36. In the event of loss of containment, however caused, many other factors will come into play in determining the level of risk. These include, for example

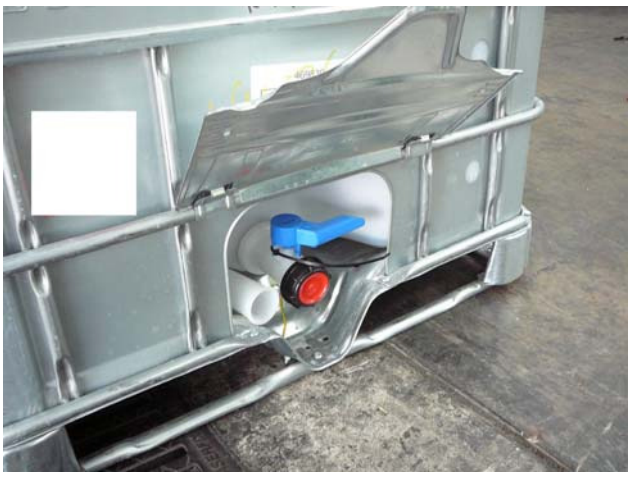
Spread or containment of spill	• Bund containment/capacity? • Quantity of substance involved? • Bund "overtopping"? • Control of drainage? • Other substances and consequences?
Risk of ignition	• Electrical? - heaters, cookers, motors, lighting, lift trucks etc • Hazardous activities? - welding, shrink-wrapping, smoking, battery charging etc
External factors	• Arson? • Fire spread from neighbours? • Vehicle impact?

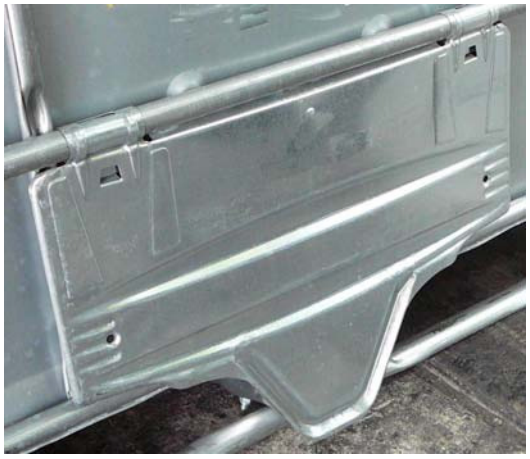
Vulnerability to fire

37. IBCs have been shown[1] to be especially vulnerable to fire even when not directly involved (see paragraph 8 above). Any risk assessment will have to consider this matter in relation to choosing the storage site, and containment of potentially large spillages. When released in this way, flammable (or combustible) liquids have the ability to spread and escalate a fire very rapidly. This will have consequences in terms of initial fire fighting, ensuring means of escape are adequate and information for the emergency services.

38. When exposed to the heat of a fire plastic IBCs can soften and fail catastrophically releasing their contents vary rapidly. If stacked this could mean the contents overtop any bund wall or kerb.

39. Plastic or composite IBCs usually, and metal IBCs sometimes, have plastic components in their valves so that progressively the valve may start to leak. Initially this may be slow, but eventually the valve may fail completely. Consideration could be given to the fitment of metal outlet valves or alternatively metal valve guards over the valve housing (sometimes known as the "doghouse"), which are more resistant to the effects of fire and which demonstrate a slower leakage failure rate. Such a guard (sometimes known as a "doghouse flap") is illustrated on page 12.





40. Metal IBCs may also fail hydraulically or by ullage space explosion. Consideration could be given to the fitment, whilst in storage, of pressure relief valves to reduce the risk of catastrophic failure in the event of fire. If a third party under contract supplies the IBC, this should be done with their permission and restored to UN specification prior to transport.

Other hazards

41. Non-flammable or non-combustible substances may be associated with other hazards such as toxicity, corrosion or oxidising potential. In each case the risk assessment will follow analogous processes so that a proper judgment may be made about controls and risk management. In the case of corrosive substances the effect of leaks or spills on other packages or storage facilities such as racking systems must be considered.

42. A suitable and sufficient risk assessment will consider all of these matters as a minimum. The list is not intended to be exhaustive but to indicate some of the known hazards associated with package storage in general and IBCs in particular. It will identify specific legislative requirements such as DSEAR[7], MHSW[3], Provision and Use of Work Equipment Regulations 1998 (PUWER)[11] that may be applicable in specific contexts.

Risk management

43. Having identified the hazards presented by the substances, their manner of storage and other factors, the assessor can consider what controls (or precautions) are, or need to be, in place to eliminate or reduce risks so far as reasonably practicable. Those controls will include

    - Minimising the quantity of liquids stored in IBCs.
    - Physical matters such as selection of lift trucks, choice of location for stores, bunding, storage racks
    - Human factors, such as selection and training of personnel
    - Organisational matters such as supervision, maintenance regimes, audit procedures

44. Collectively this process may be termed risk management and will assist the site operator to achieve legal compliance

Controls

45. Every site and situation will be different, but it is possible to set out a number of controls that properly implemented will form part of a good risk management process. Some of these are described below

Packaging

46. IBCs containing substances which are dangerous for transport should be UN certified, compatible with the products carried, properly closed and in good condition.

47. The use of metal or composite IBCs reduces the rate of fire propagation relative to all plastic IBCs, though valve components may fail and allow release of contents.

48. Studies have suggested that an IBC with a metal pallet base has a longer resistance to fire and may delay structural failure of the IBC.

49. Liquids may be packed in plastic or composite IBCs with a rigid plastic inner receptacle. The selection of an IBC for a particular liquid includes the specification of the IBC itself and its compatibility with that liquid. Ideally the IBC should be approved by the manufacturer for that particular liquid. Where there is any doubt the IBC manufacturer should be consulted and their recommendation followed. Any conditions attached to the IBC's UN certificate must be complied with.

50. The transfer of liquids from or into IBCs may create static charge with consequential ignition risks in the case of flammable liquids. In particular uncontrolled splash filling should be avoided. Some IBCs have conducting surfaces or (in the case of all metal IBCs) can be fully earthed. This will need to be considered in the DSEAR assessment and specialised advice may be needed. Further details can be found in the Solvent Industry Association Guidance notice 51[12] and HSG140[15]

Segregation

51. Generic guidance on chemical segregation is specified in HSG71[4].

52. Experience has shown that spreading pool fires that run under pallets of metal drums or metal IBCs will escalate the incident, increasing the risk of explosion. The risk may be reduced by separating plastic and composite IBCs from metal drums and metal IBCs. Flammable liquids should be kept as far away as practicable from combustible liquids (see paragraph 8). Segregation could include, for example kerbs or level grading to control the flow of burning liquid released in a fire.

Storage area

53. HSG 71[4] and HSG 51[5] recommend that storage of flammable liquids should be in the open air. This minimises risk from fires in buildings and ensures that minor leaks and spills are safely ventilated. It also minimises the risks arising from running pool fires of the sort that prejudice packages or result from gross package failure.

54. If only limited bunding is provided, to contain spillages from or failure of a single package, the effects of additional liquid that may flow out of the bund during a fire should be considered.

55. Outdoor storage has disadvantages such as Ultra-Violet light degradation of plastic packages, damage by wind and rain, and solar gain causing the packages to heat up. Lightweight weather protection can be provided to minimise these disadvantages.

56. None the less indoor storage is often used and, subject to proper risk assessment and controls, can be undertaken safely. Ventilation is important especially where flammable liquids are stored and the DSEAR assessment must consider the wider range of ignition sources likely to be present in a building.

57. The risk assessment for the site should reflect the fact that a fire in an IBC store containing flammable or combustible liquids is likely to result in the release of all of the stored liquid (i.e. failure of all of the containers) within a period of around 10 minutes.

Racking and stacking

58. IBCs may be stacked but there are limitations in both load bearing capacity (as specified in the UN certificate of approval) and differences in design. A competent person should consider these issues and draw up site rules and procedures to ensure that IBCs (or any other type of packaging) are stacked safely. As a general rule filled IBCs should be stacked no more than two high and then only when they are designed to stack together and the ground conditions are suitable.

59. Racking systems do offer the possibilities of high space utilisation. Racks should be competently designed, installed and subject to adequate inspection and maintenance regimes. Racking systems are prone to mechanical damage by lift trucks and corrosion especially where corrosive liquids are handled.

Operations

60. Operational and monitoring procedures should be capable of identifying any leaking packages and ensure they are dealt with as soon as possible, and certainly before a significant pool of combustible liquid can accumulate.

61. There should be good stock control, stock rotation and or inspection regimes as part of PUWER[11], to ensure that IBCs remain fit for purpose if used as storage vessels over a long period.

62. Containment systems such as yards, bunds, drains, interceptors and their control valves should be designed to minimise the impact of leaking IBCs. Such controls should be regularly inspected and kept in good working order.

63. Good housekeeping regimes must be implemented and maintained to prevent build-up of combustible materials and to prevent degradation of packaging from standing water in outside storage areas.

64. A “No Smoking” policy should be rigorously enforced and is a mandatory requirement for enclosed workplaces.

Emergency procedures and equipment

65. Sites subject to the Control of Major Accident Hazards Regulations (COMAH [10]) are required to have an emergency plan for which specific advice is available in HSG191[13]. Other sites should identify foreseeable emergency scenarios (e.g. fire and spillage) and put in place emergency arrangements commensurate with the risks. MHSW[3] and DSEAR[7] both require this to be done.

66. Specialised advice may be required when considering the selection and deployment of detection systems and fire fighting equipment. The hazards, their degree and quantities stored will determine the equipment required.

- Detection
  - Heat
  - Smoke
  - Vapour

- Fire fighting
  - Extinguishers
  - Hose reels
  - Sprinklers
  - Drench
    - Water
    - Foam
  - Smoke vents

67. It is recommended that contact be established with local emergency services to ensure that they have the information they need to respond effectively.

68. The potential for pollution by spillages, or fire-fighting water, needs to be considered. There may be implications for the design, materials of construction and the potential volume of containment required for a bund. There is guidance available in the joint EA/SEPA publication Pollution Prevention Guidance (PPG) 18[14] – “Managing fire water and major spillages”

Information and training

69. None of the controls will work without adequate information and training of staff. Training is a requirement of, amongst others, section 2 of the Health and Safety at Work Act 1974, MHSW[3] and PUWER[7]. Temporary employees and agency staff must be included. Where young persons are concerned more specific procedures may be needed.

70. The findings of risk assessments must be communicated to employees, and should underpin operating procedures.

71. Knowledge of the properties of substances is essential for their safe storage

72. All staff on the site must have information relevant to their roles regarding the hazards of storing liquids, the need to exclude sources of ignition and heat from the designated storage areas, and actions required in an emergency.

73. Employees must receive specific training in emergency procedures and how to deal with spillages and leaks.

74. Procedures for periodic refresher training should be considered.

75. As a minimum training should include the following aspects:

- the types of liquids stored, their properties and hazards with emphasis on combustible and flammable liquids
- general procedures for safe handling, use of lift trucks, racking and stacking
- recognition of abnormal situations
- reporting of faults and incidents, including minor leaks and spills
- use of protective clothing;
- housekeeping;
- emergency procedures, including raising the alarm, calling the fire brigade and the use of appropriate fire-fighting equipment

76. Written procedures for controlling the risks from the storage of liquids will be required, and these should be used as the basis for training.

Site security

77. The site operator will need to consider site security and where appropriate the specific provisions in ADR[17] at Chapter 1.10. This guidance does not consider this aspect of storage.

GLOSSARY

Combustible liquid: A liquid with a flash point above 60^{o} C, but which will burn in air when ignited e.g. lube oils, edible oils

Flammable liquid: Liquid with flashpoint between 23^{o} C and 60^{o} C. (PG III for transport). Note that ADR[17] includes diesel and gas oil in this classification.

Flash Point: The minimum temperature at which a liquid, under specific test conditions, will produce sufficient flammable vapour to ignite momentarily on application of an ignition source.

Hazard: That property of a material that has the potential to cause harm to people, property or the environment.

Highly flammable liquid: Liquid with flashpoint below 23^{o} C and a boiling point above 35^{o} C. (PG II for transport)

Pool Fire: When a flammable liquid is released from a storage vessel, it forms a pool on the ground. In the presence of an ignition source, this pool ignites and forms a pool fire. In some cases this will produce a “running pool fire” which can cause extensive fire spread

Risk: The chance that somebody or something could be harmed by the hazards, together with an indication of how serious the harm could be.

Vapour: The gaseous phase released by evaporation from a substance that is liquid under normal temperatures and pressure

IBC (for the purposes of this guide)

"Intermediate Bulk Container" (IBC) means a rigid, or flexible portable packaging…. that:

- has a capacity of not more than 3 m^{3} for solids and liquids of packing groups II and III;
- is designed for mechanical handling;
- is resistant to the stresses produced in handling and transport as determined by the tests specified in Chapter 6.5 of ADR[17]

Composite IBC with plastic inner receptacle: These are IBCs comprising a rigid outer structure encasing a plastic inner receptacle. It is constructed so that the outer and inner assemblies are used as an integrated single unit to be filled, stored, transported or emptied.

Organisations

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2. INDG163 - Guidance 5 Steps To Risk Assessment – ISBN-0-7176-6189-X

3. L21 - Management of Health and Safety at Work Regulations 1999 Approved Code of Practice and Guidance - ISBN 0-7176-2488-9.

4. HSG71 - Chemical Warehousing - the storage of packaged dangerous substances - 0-7176-1484-0

5. HSG51 - The storage of Flammable Liquids in containers - 0-7176-1471-9

6. CBA / SIA joint DSEAR / ATEX Guidance for the storage of flammable liquids in sealed packages in specified external storage areas.

7. L138 - Dangerous Substances And Explosive Atmospheres Regulations (DSEAR) 2002 - Approved Code Of Practice And Guidance - ISBN 0-7176-2203-7

8. The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations

9. HSG228 - CHIP For Everyone - Chemicals (Hazard Information And Packaging For Supply) Regulations 2002 - ISBN 0-7176-2370-X

10. L111 - A Guide To The Control Of Major Accident Hazards Regulations 1999 (As Amended) - ISBN 0-7176-6175-X

11. L22 - Safe Use Of Work Equipment - Provision And Use Of Work Equipment Regulations 1998 Approved Code Of Practice And Guidance - ISBN 0-7176-1626-6

12. SIA Guidance Note 51 - Use of IBC's for oxygenated and hydrocarbon solvents

13. HSG191 - Emergency planning for Major Accidents – ISBN 0-7176-1695-9

14. PPG18 - Managing fire water and major spillages - HO-6/00-12K-C-BBUD

15. HSG140 - The safe use and handling of flammable liquids – ISBN 0-7176-0967-7

16. CBA - Semi Bulk Discharge Procedure - Recommended Code Of Practice

17. ADR – European Agreement concerning the International Carriage of Dangerous Goods by Road – ISBN 92-1-139112-1

GUIDANCE

- HSE

	Publication Title	ISBN Number
HSG113	Lift trucks in potentially flammable atmospheres.	0-7176-0706-2
HSG176	The storage of Flammable Liquids in tanks	0-7176-1470-0
HSG250	Guidance on permit-to-work systems	0-7176-2943-0
L134	Design of plant, equipment and workplaces (DSEAR 2002 ACOP)	0-7176-2199-5
L135	Storage of dangerous substances (DSEAR 2002 ACOP)	0-7176-2200-2
L136	Control and mitigation measures (DSEAR 2002 ACOP)	0-7176-2001-0
L137	Safe maintenance, repair and cleaning procedures (DSEAR 2002 ACOP)	0-7176-2202-9

- Environment Agency

	Publication Title	Reference
PPG3	Use and design of oil separators in surface water drainage systems:	HO-6/01-25K-C-BBTP
PPG26	Storage & handling of drums & intermediate bulk containers	HO-02/04-12k-BHTN-AMP-EP146A

- DEFRA

Publication Title	Reference
Groundwater Protection Code - Solvent Use & Storage	PB 9849

- Energy Institute (formerly the Institute of Petroleum)

Publication Title	ISBN Number
Model Code of Safe Practice Part 15 – Area Classification Code for Flammable Liquids.	0-85293-223-5

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British Aerosol Manufacturers Association (BAMA)
British Coatings Federation (BCF)
British Lubricants Federation (BLF)
Chemical Industries Association (CIA)
Chemical Recycling Association (CRA)
Chief Fire Officers Association (CFOA)
Environment Agency (EA)
Freight Transport Association (FTA)
Industrial Packaging Association (IPA)
National Edible Oils Distributors Association (NEODA)
Scottish Environmental Protection Agency (SEPA)
Tank Storage Association (TSA)
UK Warehousing Association (UKWA)