RISCAuthority

administered by FPA Fire Protection Association

RC57: Recommendations for fire safety in the storage, handling and use of highly flammable and flammable liquids: storage in external fixed tanks

Published 2015

Symbols used in this guide

Good practice

Bad practice

Discussion topic

FAQ Frequently asked question

Acknowledgements

Figure 2 reproduced courtesy of the Health and Safety Executive.

Contents

Summary of Key Points

Comply with fire safety legislation	• In addition to a fire risk assessment undertaken in compliance with national fire safety legislation an assessment should also be undertaken by a competent person in accordance with the Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR).
Protect business continuity	• All businesses should take steps to maintain the continuity of their operations by making and rehearsing a suitable emergency plan.
Minimise the use of flammable liquids in the workplace	• Priority should be given to eliminating flammable and highly flammable liquids from the workplace wherever possible.
Provide suitable training for staff	• A training scheme should be established for the training and refresher training of staff who may be called upon to fill, drain or maintain tanks.
Identify hazard zones	• The DSEAR assessment should include identifying hazard zones in the workplace.
Plan the fire risk assessment	• The 'VICES' acronym is a key element of fire safety with flammable liquids and should be followed when carrying out the assessmen
Ventilation	• Sites selected for locating storage tanks should not be in hollows or close to drains and other areas below surrounding ground level where released flammable vapours may accumulate.
Ignition	• Identify all potential sources of ignition in the vicinity of the tanks. 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. • The possibility of deliberate fire raising should be considered as part of the fire risk assessment and a check made to ensure that there are adequate security precautions against arson and vandalism.
Containment	• Tanks should be installed on foundations designed to support the weight of the tank together with a full capacity of the most dense material that is likely to be stored within it.
Exchange	• Consider possible non-flammable or less flammable alternatives for each flammable solvent in use.
Separation	• Tanks above ground level should be located in well ventilated positions, separated from buildings and structures, process areas and the site boundary but in positions that are easily accessible by the emergency services.
Fire protection	• Consider installing a foam enhanced sprinkler installation to protect stocks of flammable and highly flammable liquids.
Environmental considerations	• The earliest possible detection of leakage from tanks and pipework is necessary to minimize the risk of fire/explosion and to prevent contamination of ground and water sources.

1 Synopsis

These recommendations give advice on the storage of flammable and highly flammable liquids in external fixed tanks located either above or below ground level.

Guidance is presented on the layout of the installations, fire prevention and protection measures and the fire safety management of the facilities. The information is provided in a manner that follows the 'VICES' criteria set out in the Dangerous Substances and Explosive Atmosphere Regulations.

2 Scope

These recommendations present measures relating to fire safety in the storage of highly flammable and flammable liquids when located in external fixed tanks. In many cases these will be fuels but may also include solvents, adhesives, resins and industrial feedstocks. Some of the liquids may present hazards other than those relating to fire, for example they may present health hazards, but these are outside the scope of this document.

The following are also outside the scope of these recommendations:

- petrol and diesel fuel stored at filling stations;
- temporary storage facilities (such as in tanks carried on vehicles or on board ships);
- the storage of highly reactive flammable liquids such as oxidising agents and chemicals which may decompose, polymerise or spontaneously combust if specific storage conditions are not observed;
- substances which are gases at ambient temperature and pressure but are stored as liquids under pressure or refrigeration (for example LPG);
- reaction vessels that are integral parts of industrial process plant;
- the construction of 'large' storage tanks (ie tanks with a diameter greater than 10m) and those with floating covers; and
- the layout of petroleum refineries, tank farms and distribution depots.

In addition, these recommendations are not applicable to sites where operations are of a scale such that The Control of Major Accidents Hazard Regulations 1999 (COMAH) (as amended) (ref 1) are applicable.

Legislation may impose requirements additional to the provisions contained in this document, thus, for example, due regard should be given to environmental protection in compliance with relevant legislation (see refs 2 to 6).

These recommendations are part of a suite of documents and should be read in conjunction with RISCAuthority recommendations RC55 and RC 56 (refs 7 and 8).

The guidance set out here should be taken into consideration when risk assessments are carried out in compliance with the Regulatory Reform (Fire Safety) Order 2005 or equivalent legislation in Scotland and Northern Ireland (refs 9-13) and the Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) 2002 (ref 14).

3 Definitions

Auto-ignition temperature

The minimum temperature at which a material will ignite spontaneously without the presence of a source of ignition.

Bund

A secondary enclosure to retain spills or leakage from tanks or containers to prevent contamination and spread of fire.

Classification of hazardous areas (BS EN 60079-10-1) (ref 15)

(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.

Competent

Someone with sufficient training and experience or knowledge and other qualities to enable them properly to implement the relevant measures.

Explosive limits (BS EN 60079-10-1) (ref 15)

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.

Figure 1: Example of a flammable warning sign

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)

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 (DSEAR 2002) (ref 14)

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 (ref 16) has a flashpoint of less than 32°C; and

(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' with a heating time of 60 seconds supports combustion.

4 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) (ref 14).

Where a dangerous substance is either present or liable to be present at the workplace, a suitable and sufficient assessment of the risks likely to arise should be conducted and action taken to eliminate or reduce the hazard as far as is reasonably practicable. Where an explosive atmosphere may occur the workplace must be classified into zones based on the frequency and duration of the explosive atmosphere (see BS 60079-10, ref 15) 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 more hazardous than those with flashpoints at higher temperatures that are unlikely to be reached in the workplace.

Two main dangers need to be recognised:

- the danger of explosion, when flammable vapour/air mixtures fall within their explosive limits; and
- the danger of fire, which may involve areas of static or flowing liquid, 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 an existing 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. In the case of external fixed tanks, the vapour density of the stored liquid will be of particular significance in the case of the escape of vapours which may accumulate in low lying areas or flow a considerable distance from the location of the leakage.

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 HSG 71 (ref 17).

These recommendations apply to all flammable and highly flammable liquids although under certain conditions some of the requirements, where liquids with higher 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 (ref 14) and the general fire risk assessment carried out in compliance with fire safety legislation (refs 9-13).

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, following an incident or near-miss and when there are changes in the:

- equipment being used;
- materials being used in the process;
- operating procedures and parameters;
- control measures that are observed;
- management of the process;
- size of the operation; or
- 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 some oxidising agents, that may be incompatible with flammable liquids, are in use in the process.

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 personnel being ignorant of the hazards associated with flammable liquids;
- lack of training: in the handling of 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;
- misuse: poor management procedures where a person engages in an unsuitable or prohibited practice (for example, smoking) with 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; and
- lack of appropriate waste management: for example of nominally empty tanks: which have been decommissioned after use in large scale operations but subsequently inadvertent steam injection has raised the temperature of the residual contents high enough to reach their auto-ignition temperature.

In addition to DSEAR, the requirements of the Control of Pollution (Oil Storage) (England) Regulations 2001 should be observed, particularly those relating to the provision of bunds (ref 6).

Changes in legislation

In 2015 a number of amendments to current legislation affecting the control and management of flammable liquids will come into operation. Most importantly:

- The Seveso II Directive, implemented in the UK as the COMAH Regulations, will be replaced in 2015 by the new Seveso III Directive. A major change will be the use of the Globally Harmonised System (GHS) for classification of chemicals to determine whether they are within the scope of the Directive. There is also the potential for sites to change their COMAH status (top tier, lower tier or non-COMAH) when the new Directive is implemented, depending on the substances and quantities held.
- From 1 June 2015 European Regulation (EC) No 1272/2008: Classification, labelling and packaging of substances and mixtures (already known as the 'CLP Regulations' will replace the Chemicals (Hazard Information and Packaging for Supply) Regulations 2009.

5 Recommendations

5.1 Compliance with fire safety legislation

5.1.1 A suitable and sufficient fire risk assessment should be undertaken for all premises to which the Regulatory Reform (Fire Safety) Order 2005 (or equivalent legislation in Scotland and Northern Ireland) applies (refs 9-13).

5.1.2 As well as the staff handling and using flammable liquids, the assessment should consider staff remote from the process area who may be affected by smoke, heat and flying debris in the event of a fire. Where large volumes of flammable liquids are stored, handled or in use the implications for other people in the neighbourhood should also be addressed. In business critical areas the implications for property protection and business continuity, as well as life safety, should also feature prominently in the assessment.

5.1.3 An assessment should be undertaken in accordance with the Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) (ref 14). In common with the fire risk assessment, this should be undertaken by a competent person; it should identify any hazard zones in the workplace.

5.1.4 Risk assessments should be the subject of periodic review, including at the time when any changes to the process, the substances involved, the method of storing or handling the substances or the treatment of waste solvents are being considered.

5.1.5 The response by fire and rescue services to 999/112 calls and signals routed via fire alarm monitoring organisations varies widely throughout the UK, and differs from day to night-time. Fire safety managers should refer to the relevant fire and rescue service to make themselves aware of the levels of response in the areas in which their premises are located and consider this information when undertaking and reviewing their fire risk assessments.

5.2 Business continuity

Even a small fire can have a disproportionate effect on a business if it occurs in a critical area. The use of solvents is hazardous and must be carefully managed to avoid unnecessary disruption to the efficient functioning of the business.

5.2.1 In commercial premises where processes routinely involve the use of flammable or highly flammable liquids, the fire hazards and thus the threat to the business are increased if the processes are allowed to continue unattended. If it is intended that equipment is to be left operating without staff in attendance then a specific risk assessment for the process should be undertaken. (Further information regarding unattended processes is set out in RISCAuthority recommendations RC42 (ref 18)).

5.2.2 All businesses should take steps to maintain the continuity of their operations by making a suitable emergency plan. Guidance for this is set out in *Business resilience: A guide to protecting your business and its people* (ref 19). The emergency plan should address the implications of a fire, flood or other perceived disaster on all facets of the business model. It should indicate the lines of communication that should be followed and the contact details for specialist assistance, providers of alternative accommodation and suppliers of replacement equipment.

5.2.3 Tabletop exercises should be held periodically to test the effectiveness and suitability of the emergency plans.

5.2.4 Consideration may be given to applying commercially available computer programs, such as the ROBUST software (Resilient Business Software Toolkit) that is available free of charge (ref 20), or similar product, to develop and check the adequacy of the plan.

5.3 Fire safety management

- Close liaison should be established with the fire and rescue service so that they may become familiar with the layout and nature of the hazards on the site.
- Specialist advice should be sought regarding the provision of facilities for emergency pressure release.

5.3.1 At the outset, attention should 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-flammable liquids as alternatives, or at least with those having a flashpoint above 55°C.

5.3.2 For quantities greater than 25 tonnes the storage location should be marked in accordance with the Health and Safety (Safety Signs and Signals) Regulations 1996 (ref 5). On certain sites where dangerous substances are stored, signs in accordance with the Dangerous Substances (Notification and Marking of Sites) Regulations 1990 (ref 21) should be displayed.

5.3.3 Where appropriate, competent authorities should be notified and emergency action plans prepared in compliance with the Control of Emergency Accident Hazards (COMAH) Regulations 1999 (as amended) (ref 1).

5.3.4 All tanks and filling points should be marked with the name of the liquid in the tank. This is especially important where several different liquids may be loaded or unloaded from a common location. Additional precautions may be necessary where incompatible liquids are being handled.

5.3.5 The method of operating isolation and control valves should be indicated by signs or labels where necessary.

5.3.6 The security of tanks of highly flammable and flammable liquids is of the utmost importance. All storage tanks should be within a secure area protected by suitable perimeter protection such as welded mesh or a palisade complying with a recognised standard (for example BS 1722-12 (ref 22). If the site is enclosed and there is a security access control system in place there may be no requirement for an additional fence around the tank or bund.

5.3.7 Where tanks are enclosed individually or in groups, no fewer than two gates should be provided for access and escape.

5.3.8 No hot work should be performed on or near a tank unless a suitable and sufficient

risk assessment has been undertaken and a competent person has issued a permit to work under a hot work permit scheme operated in accordance with RISCAuthority recommendations RC7 (ref 23).

Staff training

5.3.9 A training scheme should be established and monitored for the training and refresher training of staff who may be called upon to fill, drain or maintain tanks.

5.3.10 All staff members should be trained in:

- the hazards associated with the storage of highly flammable and flammable liquids on the premises;
- the precautions in the filling and discharging of the tanks;
- the action to take in the event of a spillage or fire; and
- raising the alarm and implementing the emergency procedures.

5.3.11 Staff should be made aware of the hazards of deliberate fire raising, which may be carried out by colleagues as well as by intruders.

5.4 VICES

5.4.1 The HSE guidance in booklet HS(G)51 (ref 24) suggests the use of the acronym VICES to help apply five basic principles which ensure that any flammable or highly flammable liquid that cannot be substituted in the workplace is used and stored with appropriate care.

5.4.2 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.

5.4.3 The acronym may be explained as follows:

V Ventilation (see section 5)

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

I Ignition (see section 6)

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

C Containment (see section 7)

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

E Exchange (see section 8)

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

S Separation (see section 9)

- Is the storage of liquids separated from other stored materials?
- Are incompatible materials suitably separated?
- Are physical barriers (such as fire walls) present as required?

5.5 Ventilation

5.5.1 Tanks may be located below or at ground level. Storage at ground level, in the open air has the advantage that any vapours produced will normally be dissipated by natural ventilation and also has the benefits that a leak may readily be detected and the condition of the tank may easily be monitored.

5.5.2 To enable adequate ventilation in the open air, sites selected for locating storage tanks should not be in hollows or close to drains and other areas below surrounding ground level where released flammable vapours may accumulate.

5.5.3 Open air storage tanks should be away from buildings and structures that may prevent an adequate flow of air for ventilation.

5.5.4 Care should be taken when siting new tanks or structures in the vicinity of existing tanks, that conditions are not created that may be conducive to the accumulation of any released flammable vapours.

5.5.5 Consideration should be given to the possible release of flammable vapours from vent and fill lines and dip tube connections (where these are employed). Tanks containing flammable liquids should be fitted with safety valves or vents for protection against pressure or vacuum in excess of their design criteria.

5.5.6 Vents must not be less than the diameter of the filling or discharge line and not less than 25mm in diameter. Where liquid is pumped into a tank the vent size must be based on a calculation of the flow rates.

5.5.7 Vent outlets should be located at least 3m but not more than 6m above ground level, or 1m above the top of the tank, whichever is the higher and should discharge to a safe location in the open air at least 3m clear of window and door openings.

5.5.8 The vent discharge point should always be at least 1m higher than the top of the delivery tanker in the case of gravity delivery.

5.5.9 If delivery is by pump, high level alarms should be fitted to the tank or pre-set pump metering used (see paragraph 7.45).

5.5.10 Ventilation pipes should be adequately secured.

5.5.11 A flame arrester should normally be installed at the vent outlet of any tank containing a liquid with a flashpoint of 21°C or less. A flame arrester should not be fitted where a pressure-vacuum vent valve is provided.

5.5.12 Flame arresters should be inspected regularly to ensure that they have not been obscured by paint or become obstructed, for example by polymerised materials. Flame arresters should be included on the planned preventive maintenance programme.

5.5.13 In addition to vents designed to cope with pressure fluctuations during normal operations, additional measures should be provided to relieve excess pressure resulting from fire engulfment. This may be provided by:

- oversize or additional vents;
- manholes or hatch covers which raise under excessive internal pressure;
- weakened roof to wall joints; and
- purpose made devices.

5.5.14 Specialist advice should be sought in the provision of emergency pressure relief.

5.6 Ignition

5.6.1 One of the major objectives of any fire risk assessment of the tank area is to identify potential sources of ignition in the vicinity of the tanks. 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 sources of ignition should be eliminated as far as practicable and temperatures of surfaces maintained well below the auto-ignition temperature of the liquid. (See also RC55, ref 7.)

5.6.2 Smoking must be prohibited in all external areas where flammable liquids are used or stored and prominent notices to this effect be displayed.

5.6.3 The risk assessments undertaken for open air tank storage areas should also seek to mitigate the hazards associated with motor vehicles being introduced into the proximity (see 5.6.22).

Electrical equipment

5.6.4 Electrical equipment and wiring should be certified as suitable for use within the zone in which the flammable liquid is being stored or processed (see ref 15) as determined by a risk assessment undertaken by a competent person. They should also comply with the provisions of the Electricity at Work Regulations 1989 (ref 25). All electrical installations and their maintenance should comply with BS EN 60079-14 (ref 26). (Hazard zones should be identified in the risk assessment undertaken in compliance with DSEAR.)

5.6.5 There should be adequate level of lighting (at least 50 lux) for safe working at all times; a higher level may be needed in areas where level gauges have to be read.

Static electricity

5.6.6 The potential hazard of ignition due to a build-up of static electricity during movement or transfer of flammable liquids should be assessed and precautions taken to eliminate it (see ref 27).

5.6.7 All metal tanks, associated extraneous pipework and fittings used for handling flammable and highly flammable liquids must be electrically bonded and earthed (see ref 27); non-static tools should be used when working in bunds and consideration should be given to any additional measures necessary to prevent the build up and uncontrolled discharge of static electricity as determined by risk assessment.

5.6.8 Bonding and earthing should be subject to an annual continuity test; suitable records should be kept.

5.6.9 Care should be taken to ensure satisfactory electrical bonding between flexible hoses and adjacent conventional pipework. Where necessary, bridging cables should be used to link the adjacent pipes directly.

5.6.10 An earth lead for connection to the tanker should be provided for attachment before filling operations commence. Dip rods and tubes should also be earthed.

5.6.11 The tank filling line should extend below the lowest normal operating level of the tank to minimise the generation of static electricity during filling operations. To prevent siphoning the line should be self draining (suitable arrangements have to be made where a single pipe is used both for filling and emptying a tank.)

Tank heating

5.6.12 Heated tanks and their equipment should be constructed to an appropriate standard (such BS 799-5 (ref 28)).

5.6.13 For economy as well as safety, heating of tanks should be kept to a minimum compatible with effective working practices. The flashpoint of the liquid should not be exceeded and heating rates should be low to allow ease of control of the system.

5.6.14 Tank heating equipment should incorporate duplicate temperature sensors and thermostats and a high temperature limit device. The high temperature limit device should prevent the temperature of the liquid exceeding a temperature 10˚C below its boiling point and should not be fitted with an automatic reset.

5.6.15 Any vessel containing internal heating elements should be fitted with duplicate low liquid level alarms and cut-outs to prevent the heating elements being exposed to vapours within the tank. In addition, the outlet pipe should be located above the heating coil or element.

5.6.16 Temperature probes, thermostats and associated control equipment should be tested as part of the periodic maintenance programme for the installation. The results should be recorded.

5.6.17 If a drain pipe is fitted at a level lower than the heating coil or element it should be fitted with a closed valve and a blanking plate to deny its use during normal operations.

5.6.18 Tanks should only be drained following cooling of the contents to ambient temperature.

5.6.19 Where a water layer cannot be avoided the heating system should be incapable of raising the temperature above 100˚C.

5.6.20 Trace heating of pipework may be necessary and vent pipes and flame arresters may also need to be heated.

5.6.21 Any insulation of tanks or pipes should be of non-combustible material. Insulation contaminated by spillages or leaks of flammable liquids should be replaced.

Vehicles

5.6.22 Where trucks have to be used in a zone in which a flammable vapour may be present only trucks certified to the appropriate electrical zoning standard should be used (see HSE Guidance HSG 113, ref 29). This should be identified in the risk assessment undertaken in compliance with DSEAR (ref 14).

5.6.23 Roadways should be sufficiently wide to permit safe manoeuvring of any vehicle requiring access to areas in the vicinity of storage tanks.

5.6.24 Suitably positioned barrier rails should be considered to minimise the risk of impact damage to bunds, pipework and associated fittings.

5.6.25 Battery-powered trucks should not be charged within a zone in which a hazardous atmosphere may be present.

5.6.26 The gas cylinders of LPG fuelled vehicles should not be changed in the vicinity of storage tanks or in other areas where highly flammable or flammable liquids are stored or used.

Arson prevention

FAQ

- How can the security of the site be improved to deter deliberate fire raising?
- How can I organise a tabletop exercise to test the effectiveness and suitability of my emergency plans?

5.6.27 When planning the site for positioning a flammable liquid storage tank, the possibility of deliberate fire raising should be considered as part of the fire risk assessment and a check made to ensure that there are adequate security precautions against arson and vandalism. Precautionary measures should be proportionate to the risk, the quantity and nature of the flammable liquids stored and be based on the findings of the risk assessment. Further information is set out in RISCAuthority recommendations RC48 (ref 40) and an FPA book (ref 31).

5.6.28 The area immediately surrounding a flammable liquid storage tank should be kept free from combustible materials, including waste, weeds and dried vegetation. Chlorate-based weed killers should not be used to control the undergrowth.

5.7 Containment

Tank construction

- Where tanks are compartmented, incompatible materials must not be stored in the same tank.

5.7.1 Tanks should be constructed in compliance with a recognised standard (for example refs 32-34) and the materials used should be compatible with the highly flammable or flammable liquids being stored.

5.7.2 Particular care needs to be paid to the protection of tanks constructed of glass reinforced plastic or similar materials to ensure that they maintain their integrity in the event of a fire.

5.7.3 Where access is provided for personnel wearing protective clothing and breathing apparatus the inside diameter of the manhole should be at least 600mm.

5.7.4 Where tanks are compartmented, incompatible materials must not be stored in the same tank. For example adjacent compartments should not be used for the storage of aromatic hydrocarbons and chlorinated solvents.

Table 1: Examples of some common incompatible chemicals

Chemical	Incompatible chemicals
Acetone	Concentrated sulphuric acid and nitric acid mixtures
Aniline	Nitric acid, hydrogen peroxide
Chromic acid	Acetic acid, naphthalene, camphor, glycerine, turpentine, alcohols and many flammable liquids
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Hydrocarbons	Fluorine, chlorine, bromine, chromic acid, sodium peroxide
Hydrogen peroxide	Copper, chromium, iron, most metals or their salts, alcohols, acetone, organic materials, aniline, nitromethane, flammable liquids, oxidizing gases
Nitric acid (conc.)	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulphide, flammable liquids, flammable gases
Perchloric acid	Acetic anhydride, bismuth and its alloys, ethanol, paper, wood
Phosphorus (white), potassium	Air, alkalies, reducing agents, oxygen carbon tetrachloride, carbon dioxide, water, alcohols, acids
Potassium permanganate	Glycerin, ethylene glycol, benzaldehyde, sulphuric acid
Sodium	Carbon tetrachloride, carbon dioxide, water
Sodium peroxide	ethanol, methanol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural

5.7.5. To prevent corrosion, coating should be provided by paints or other products selected and applied in compliance with a recognised standard (see refs 35 and 36).

5.7.6. Internal corrosion may result from water accumulating in the tank. There should be provision for the removal of this with drainage being protected by two in-line valves.

5.7.7. Tanks should be installed on foundations designed to support the weight of the tank together with a full capacity of the most dense material that is likely to be stored within it.

5.7.8. Tanks should be secured to their supports or weighted to avoid floatation in the event of flooding or spillage of liquid into the bund.

5.7.9. Where tanks are raised above ground level in bunds their supports should be fire resistant to a 2 hour standard.

5.7.10. Where plastic tanks are used then their bases must be fully supported. The tanks should not be mounted on piers to prevent the risk of structural failure.

5.7.11. Tanks below ground require adequate foundations and supports, secure anchorage and appropriate corrosion prevention.

5.7.12. The space around tanks below ground should be backfilled with pea gravel or similar inert material with small particle size to avoid damaging the coating of the tank.

5.7.13. The locations of underground tanks should be marked prominently to prevent damage by traffic above. Where necessary, protection may have to be provided by a reinforced concrete slab.

FAQ

- Does my double skin storage tank have to be located in a bund?
- Should specially protected trucks be used to carry flammable liquids around the site?

Bunding

5.7.14. Secondary containment areas, or bunds, need to be provided to retain leakage, guard against the risk of pollution and contain a possible flowing liquid fire.

5.7.15. Bunds should incorporate an impervious sill or low wall, at least 150mm high.

5.7.16. Bunds should have a capacity of not less than 110% of the contents of the largest container in the bund or 25% of the aggregate storage capacity of the containers, whichever is greater.

5.7.17. Bunds must have a base and walls which are impermeable to oil and water and treated with a proprietary sealing product where necessary to maintain this property.

5.7.18. They should, wherever practicable, have a base and walls which are not penetrated by any drain pipe, valve or opening.

5.7.19. Where it is necessary for a fill or draw-off pipe to pass 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 flammable liquid or water.

5.7.20. Accumulations of rainwater should be pumped out of the bund periodically; the polluted water should not be allowed to enter drains.

5.7.21. When designing a bund, consideration should be given to minimising the surface area of any spillage while at the same time maintaining the height of the bund walls at a level at which access can be gained for firefighting. Where the bund is deeper than 300mm mechanical ventilation should be provided.

5.7.22. Tanks and bunds must be positioned so as to minimise the risk of damage by impact as far as practicable. Where necessary, sills or bollards should be provided to minimise vehicular damage.

5.7.23. Where there are multiple tanks in bunds these should be separated by suitable distances (see paragraph 5.9.4) and low intermediate walls, typically half the height of the bund, should be provided.

5.7.24. All parts of the tanks should be readily accessible to enable leakages to be easily identified.

5.7.25. Tanks should not be located one above another.

5.7.26. A tank with rigid integral bunding ('double skin' storage tanks) may be considered to be a tank within a tank and thus not require additional bunding providing that an intrinsically safe monitoring system is incorporated into the design. Hazards associated with pipework, valves and other fittings outside of the tank should be addressed in the fire risk assessment.

5.7.27. Pumps should be located inside bunds on concrete bases in the open air, so as to be above the level of the bund walls.

Pipework

5.7.28. Pipework should preferably be installed above ground level where it can easily be inspected and maintained. It also has the advantage that any leaking vapour is dissipated by natural ventilation.

5.7.29. The pipework should normally be constructed of metal. All elements of the installation, including valves, seals and flange gaskets, should be compatible with the contents of the tank to ensure the integrity of the system.

5.7.30. As every pipe entering a tank is a potential source of leakage, each pipe should be provided with a suitable valve to allow it to be isolated. These valves should be located inside the bund and close to the tank. Consideration should be given to the fitting of remotely operated shut-off valves to pipes that may need to be closed in an emergency without delay. Where these are fitted manual controls should remain accessible in the event of power failure.

5.7.31. Valves should also be provided, where necessary, to prevent the backflow of products or process materials into the tank.

5.7.32. Pipework should be routed carefully and suitable precautions should be taken to protect the system, especially where gantries are involved. In order to minimise accidental damage from passing vehicles the use of barriers, bollards and kerbs may have to be considered.

5.7.33. Pipework should be marked prominently in accordance with BS 1710 (ref 37) to indicate the contents and direction of flow.

5.7.34. Valves should be labelled as to their function and, where necessary, their method of operation.

5.7.35. All valves should be exercised (by closing and opening them fully) and tested periodically to ensure that they will work correctly and effectively in an emergency.

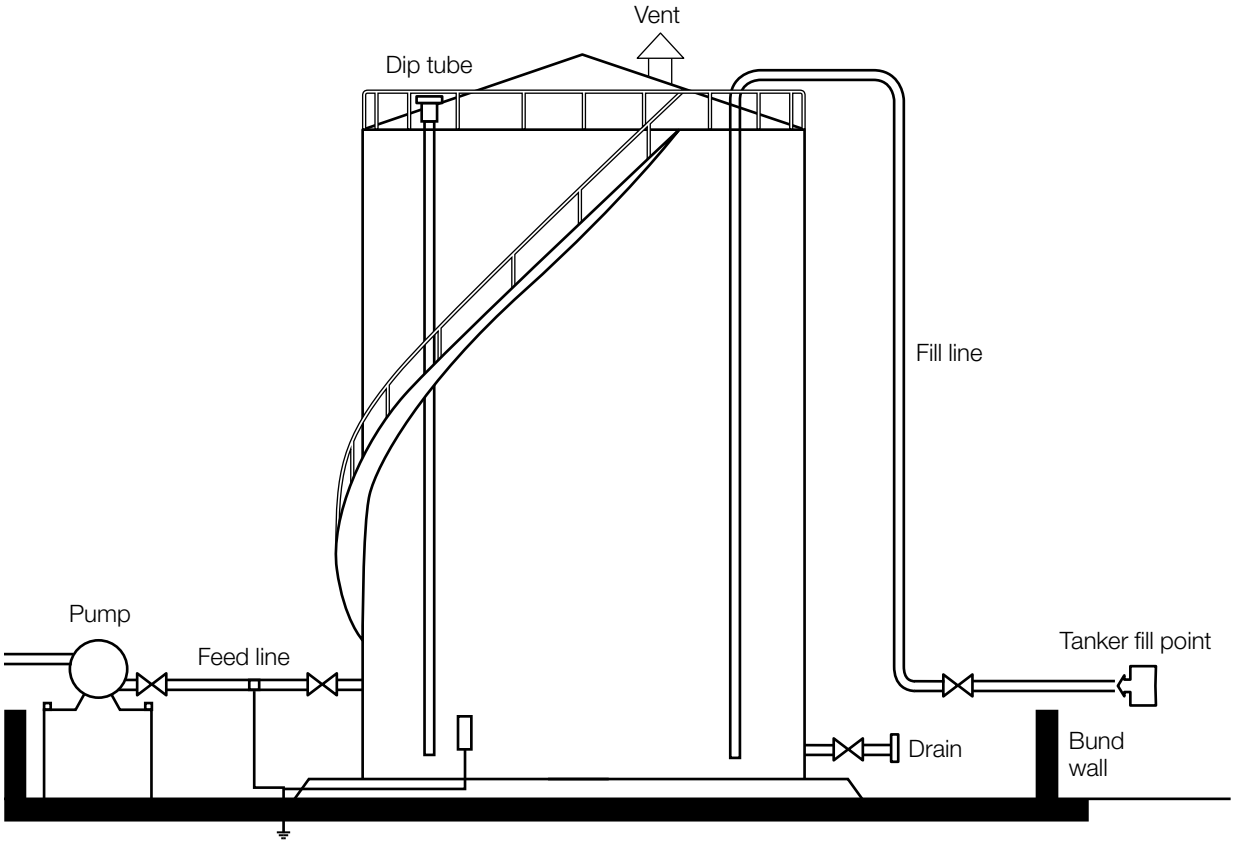
5.7.36. Measures should be installed to prevent excessive pressure building up as a result of the thermal expansion of liquid trapped in pipework or between shut-off valves. This may take the form of hydrostatic relief valves designed to discharge back to the tank or to a safe area such as a sump or collection vessel.

5.7.37. Appropriate measures should also be provided for movement between tanks and supports.

5.7.38. Minimising the diameter and length of the pipes reduces the potential for spillage in case of an accident.

5.7.39. Where it is necessary to lay pipework beneath ground it should be laid in a masonry or concrete lined trench and be protected by load bearing covers. Provision should be made to prevent water from accumulating in the trench, which should not be used for carrying other services such as electrical wiring, compressed gases, corrosive or incompatible materials.

Figure 2: Typical vertical storage tank (modified from HSG176 (ref 38)



5.7.40. The pipework should be inspected periodically, with the results being recorded, especially in the region of joints, and access should be available for any valves below ground level.

5.7.41. Flexible hoses should only be used where vibration is a problem, they should be installed, supported and maintained as directed by the manufacturer. Flexible hoses should only be installed above ground level.

Tank filling

5.7.42. Tank filling should only be undertaken by an authorised person.

5.7.43. Tank filling connections, together with those for emptying, dipping and venting, should be located at least 4m from any source of ignition, building opening, trench or depression in the ground. Any drain in the vicinity should be fitted with an interceptor and be routed to a waste collection and treatment facility.

The bases of plastic tanks should be fully supported to prevent the risk of structural failure.

5.7.44. Filling points should be accessible by road tankers without the need for reversing the vehicles. They should be dedicated to tanker use only and not normally be accessible to other road vehicles or pedestrians. A facility should be available to avoid waiting tankers being parked on public or internal roads.

5.7.45. Fill lines should enter the tank at the top.

5.7.46. Tanks containing highly flammable and flammable liquids must be fitted with a proprietary overfill prevention system incorporating a means of shutting off the flow and raising an alarm at a remote area that is permanently manned when refilling operations are taking place.

5.7.47. The connection point for filling or discharging should be outside the bund wall and close to the tanker stand to minimise the length of the connections.

5.7.48. The filling operations should at all times be under the control of the receiving organisation.

5.7.49. Filling should be undertaken using a fixed pump on site rather than a vehicle mounted pump to allow all equipment on the vehicle to be switched off during the operation and so as to avoid subjecting the vehicle flexible hose and coupling to pump discharge pressures.

5.7.50. Filling points should be equipped with non-return valves located close to the shut-off valve to minimise any spillage if the shut-off valve fails to seal.

5.7.51. Spillage from making and breaking connections should be collected in a drip tray and be disposed of safely, for example by draining to a safe place (see 7.37).

5.7.52. Filling lines should be capped when not in use; consideration should be given to fitting locking caps.

5.7.53. Each tank should be fitted with a liquid level device. Dial gauges are preferable to sight gauges. Where, however, sight gauges are fitted, they should be protected against damage and fitted with a stop valve or self-closing valve. Because of the potential for large liquid leakage if a sight gauge is damaged, it is important that such valves are closed after readings are taken. Overfill alarms on tanks should be totally independent from the sight gauges.

5.7.54. Dial or electronic gauges should be calibrated on installation and periodically thereafter as part of the tank inspection programme.

5.7.55. Physical dipping of tanks should be avoided if possible, in order to minimise the risk of ignition by static electricity and to reduce the likelihood of insecure replacement of the dip cap.

Spillage

5.7.56. Appropriate quantities of suitable materials should be available to retain and absorb spillages. Staff should be trained in the safe use and disposal of these materials.

5.8 Exchange

5.8.1 Although it is the fourth letter of the acronym 'VICES', exchange refers to the primary need to ensure that highly flammable and flammable liquids are eliminated from the workplace if at all possible. Each such liquid should be considered in turn and possible non-flammable or aqueous alternatives be considered. (A successful example of the practical application of this principle is to be found in several industries where flammable white spirit-based paints and inks have been replaced with water-based alternatives.)

5.9 Separation

5.9.1 Tanks should not be installed on roofs of buildings.

5.9.2 Tanks above ground level should be located in a well ventilated position, separated from buildings and structures, process areas and the site boundary but in a position with easy accessibility by the emergency services.

5.9.3 Separation distances will be mainly dependent and on the capacity of the tank; 'small' tanks being those associated with industrial processes, with diameters of less than 10m while 'large' tanks, as the terminology suggests, being those most commonly encountered in refinery and large scale storage facilities. (The protection of 'large' tanks is outside the scope of this document.)

5.9.4 Minimum recommended separation distances for 'small' tanks are set out in Table 2. Small tanks may be grouped together provided that the aggregate capacity of the group is not in excess of 8000m^3 and the tanks are all accessible for firefighting purposes. (It should be noted that if a serious fire were to develop then the separation distances are not sufficient to prevent damage or fire spread to adjacent tanks but a sufficient time should be available for evacuation of personnel from the area and emergency plans to be implemented.)

5.9.5 The insurer should be consulted regarding the separation of groups of 'small' tanks and 'large' tanks from site boundaries, buildings, process areas, fixed sources of ignition and other hazardous materials.

Table 2: Minimum separation distances for single 'small' tanks from site boundaries, buildings, process areas and fixed sources of ignition. (From HSE Guidance HSG176 (ref 38).)

Tank Capacity (m^3)	Separation distance (m)
Less than or equal to 1	1*
Greater than 1 and less than or equal to 5	4
Greater than 5 and less than or equal to 33	6
Greater than 33 and less than or equal to 100	8
Greater than 100 and less than or equal to 250	10
Greater than 250	15

Note

* But at least 2m from doors, plain glazed windows or other openings or means of escape. Also not below any opening (including building eaves and means of escape) from an upper floor, regardless of vertical distance.

5.9.6 The separation distances between 'small' tanks arranged in groups are set out in Table 3. For the purpose of determining the separation distances from site boundaries, buildings, process areas and fixed sources of ignition a group of small tanks may be considered to be a single tank.

Table 3:

Tank Capacity (m^3)	Separation distance between tanks (m)
Less than 100	The minimum required for safe construction and operation
Greater than 100 but less than 10m in diameter	Equal to or greater than 2m

Underground tanks

5.9.7 Where it is necessary to site tanks underground, they should be outside the building line. The distance from any part of the tank to the building line should not be less than 2m. If a building has a basement or pit the distance should be 6m.

5.9.8 Where underground tanks are sited in a position where they are likely to be subjected to undue loadings from any cause (for example vehicular traffic) either the area should be fenced off or the tanks be located in a pit constructed of reinforced

concrete with a reinforced concrete slab cover. The pit should be ventilated and may need to be monitored for the presence of flammable vapours.

5.9.9 The installation of tanks in areas with a high water table should be avoided.

Maintenance

5.9.10 Bunds, interceptors, loading and unloading facilities, as well as the tanks and associated valves and pipework should be regularly inspected and maintained, on a risk assessed basis, by a competent person. Suitable records should be made of the inspections and other work undertaken.

Decommissioning

5.9.11 Empty tanks may still contain significant traces of liquid and/or flammable vapours and thus be extremely hazardous.

5.9.12 A decision has to be taken at the planning stage as to whether a tank is to be taken out of service permanently and hence be demolished, or be cleaned and maintained for possible future use. When a decision has been made, a risk assessment should be undertaken to identify hazards associated with the intended course of action.

5.9.13 When decommissioning and/or demolishing a tank the vessel should be physically isolated from any plant, process or other storage vessel. The use of valves to isolate tanks in these circumstances is not acceptable.

5.9.14 Following isolation, the tank should be emptied as much as possible, vented, cleaned and gas freed. The procedures set out in the HSE Guidance note CS 15 (ref 39) should be followed.

5.9.15 Tanks to be decommissioned for possible future use should be cleaned as indicated above or filled with water or an inert gas such as nitrogen. If an inert gas is used, the tank should be prominently labelled to prevent unauthorised entry into an atmosphere that will not support life.

5.9.16 All work undertaken on decommissioning tanks should be carried out under a permit to work system.

5.9.17 The decommissioning of underground storage tanks should follow the guidance set out by the Energy Institute (ref 40).

5.10 Fire protection

5.10.1 Fire protection measures for areas where flammable and highly flammable liquids are stored, handled or used should be proportionate to the risk and be based on the findings of the fire risk assessments carried out in compliance with fire safety legislation and DSEAR (refs 9-14).

5.10.2 All storage facilities, including external areas in the immediate vicinity of storage tanks, should be fitted with a manually operated fire alarm system that will sound and be audible in all areas of the storage facility above the background noises (assuming a minimum noise of 65dB(A)), in accordance with BS 5839-1 (ref 41).

5.10.3 In zoned hazardous areas, it may be necessary for fire alarm systems and communications systems to be intrinsically safe and appropriate for the zone in which they are installed.

5.10.4 Consideration should be given to protecting storage tanks with a suitably designed fixed foam or water spray fire protection system. Such a system should be provided where indicated by a risk assessment, but only after consultation with the fire and rescue service and insurer of the facility.

5.10.5 Sufficient water supplies for cooling tanks should be available. A flow rate to provide 10litres/min/m^2 for 30 minutes is recommended for a water spray system to keep a tank affected by flame impingement cool (see ref 38).

5.10.6 Effective liaison should be maintained with the fire and rescue authority with regard to:

- access to tanks, buildings, hydrants, monitors and fixed installations relevant to the site operations;
- the layout of the site;
- the planned actions of any on-site firefighting or emergency action team and the equipment at their disposal; and
- the adequacy of water supplies, both on site and in the neighbourhood, for fire brigade use for cooling tanks or fighting fires.
- The availability of foam concentrates and other firefighting media

5.10.7 A suitable number of appropriate portable fire extinguishers, approved and certificated by an independent, third-party certification body, should be provided in accordance with BS 5306-8 (ref 42) and maintained in compliance with BS 5306-3 (ref 43).

5.11 Environmental considerations

5.11.1 The storage of highly flammable liquids such as oils, petrol and other solvents is addressed by a number of items of environmental legislation and guidance which varies according to the region of the UK and the regulatory agency involved. It is all aimed at preventing the release of such materials into the environment, ie into water courses, the air or onto land.

Best practice guidance for environmental protection from above ground oil tanks is set out in Pollution Prevention Guidelines: PPG 2: Above ground Oil Storage Tanks (ref 44). This is published jointly by the Environment Agency for England and Wales, the Scottish Environment Protection Agency and the Environment and Heritage Protection Service in Northern Ireland.

5.11.2 The earliest possible detection of leakage from tanks and pipework is necessary to minimise the risk of fire/explosion and to prevent contamination of ground and water sources. Quantities of highly flammable and flammable liquids used should be monitored and compared with those delivered; any variations should be investigated.

5.11.3 Suitable fire water run-off and retention facilities should be provided and the adequacy of these should also be discussed with the fire and rescue service. Interceptor tanks or special drainage facilities may be necessary to minimise the risk of pollution to water courses. On large sites liaison should be maintained with the water supply company and the Environment Agency.

5.11.4 The design, installation and maintenance of underground storage tanks require specialist advice to minimise the likelihood of underground pollution. Additional information should be sought from the Environment Agency or equivalent organisations in Scotland and Northern Ireland.

5.11.5 Legislation restricts the discharge of vapour to the atmosphere. Vapour balancing systems will be necessary for most new installations and may need to be retrofitted. Specialist advice should be sought.

In some areas of the UK ground water sources are very close to the surface. In such areas fire and rescue services are now required to obtain permission from the Environment Agency before releasing firefighting water so as to minimise the risk of polluting drinking water.

6. Checklist

		Yes	No	N/A	Action required	Due date	Sign on completion
6.1	**Compliance with fire safety legislation (section 1)**						
6.1.1	Has a suitable and sufficient fire risk assessment been undertaken for all premises to which the Regulatory Reform (Fire Safety) Order 2005 (or equivalent legislation in Scotland and Northern Ireland) applies? (5.1.1)						
6.1.2	Does the assessment consider staff remote from the process area who may be affected by smoke and heat in the event of a fire? (5.1.2)						
6.1.3	In business critical areas, do the implications for property protection and business continuity, as well as life safety feature prominently in the assessment? (5.1.2)						
6.1.4	Has an assessment been undertaken in accordance with the Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) that identifies hazard zones in the workplace? (5.1.3)						
6.1.5	Are the risk assessments the subject of periodic review, including at the time when any changes to the process, the substances involved, the method of storing or handling the substances or the treatment of waste solvents are being considered? (5.1.4)						
6.1.6	Has reference been made to the relevant fire and rescue service to become aware of the levels of response in the areas in which the premises are located? (5.1.5)						
6.2	**Business continuity (section 2)**						
6.2.1	If it is intended that equipment is to be left operating without staff in attendance then has a specific risk assessment for the process been undertaken and appropriate control measures introduced? (5.2.1)						
6.2.2	Have steps been taken to maintain the continuity of operations by making a suitable emergency plan? (5.2.2)						
6.2.4	Does the emergency plan indicate the lines of communication that should be followed and the contact details for specialist assistance, providers of alternative accommodation and suppliers of replacement equipment? (5.2.2)						
6.2.5	Are tabletop exercises held periodically to test the effectiveness and suitability of the emergency plans? (5.2.3)						
6.2.6	Is consideration given to applying commercially available computer programmes, such as the ROBUST software (Resilient Business Software Toolkit) or a similar product to develop and check the adequacy of the plan? (5.2.4)						
6.3	**Fire safety management (section 3)**						
6.3.1	Is attention given to eliminating flammable and highly flammable liquids from the workplace wherever possible? (5.3.1)						

		Yes	No	N/A	Action required	Due date	Sign on completion
6.3.2	For quantities greater than 25 tonnes, is the storage location marked in accordance with the Health and Safety (Safety Signs and Signals) Regulations 1996? (Or with the Dangerous Substances (Notification and Marking of Sites) Regulations 1990 where relevant?) (5.3.2)						
6.3.3	Where appropriate, are competent authorities notified and emergency action plans prepared in compliance with the Control of Emergency Accident Hazards (COMAH) Regulations 1999 (as amended? (5.3.3)						
6.3.4	Are all tanks and filling points marked with the name of the liquid in the tank? (5.3.4)						
6.3.5	Is the method of operating isolation and control valves indicated by signs or labels where necessary? (5.3.5)						
6.3.6	Are all storage tanks within a secure area protected by suitable perimeter protection such as welded mesh or a palisade complying with a recognised standard? (5.3.6)						
6.3.7	Where tanks are enclosed individually or in groups are at least two gates provided for access and escape? (5.3.7)						
6.3.8	Is hot work prohibited on or near a tank unless a suitable and sufficient risk assessment has been undertaken and a competent person has issued a permit to work under a hot work permit scheme? (5.3.8)						
6.3.9	Has a training scheme been established and monitored for the training and refresher training of staff who may be called upon to fill, drain or maintain tanks? (5.3.9)						
6.3.10	Are all staff members trained in the hazards associated with the storage of highly flammable and flammable liquids on the premises and the action to take in the event of a fire? (5.3.10)						
6.3.11	Are staff made aware of the hazards of deliberate fire raising, which may be carried out by colleagues as well as by intruders? (5.3.11)						
6.4	**VICES (section 4)**						
6.4.1	Has the HSE guidance in booklet HS(G)51, which suggests the use of the acronym VICES, been used to help apply five basic principles which ensure that any flammable or highly flammable liquid that is necessary in the workplace is used and stored with appropriate care? (5.4.1)						
6.4.2	Is suitable staff training 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? (5.4.2)						
6.4.3	Ventilation: Is there sufficient ventilation to keep the concentration of the liquid's vapour below its lower explosive limit? (5.4.3)						
6.4.4	Ignition: Have all possible ignition sources been removed and is the electrical equipment used in this area suited to the risk category? (5.4.3)						

		Yes	No	N/A	Action required	Due date	Sign on completion
6.4.5	Containment: (5.4.4) • 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?						
6.4.6	Exchange: Can the flammable substances can be eliminated from the workplace or be replaced by less flammable ones? (5.4.5)						
6.4.7	Separation: Are flammable liquids stored separate from other stored materials and are physical barriers present as required? (5.4.6)						
6.5	**Ventilation (section 5)**						
6.5.1	Are tanks located so that a leak may readily be detected and the condition of the tank may easily be monitored? (5.5.1)						
6.5.2	To enable adequate ventilation in the open air, are tanks sited away from hollows, drains and other areas below surrounding ground level where released flammable vapours may accumulate? (5.5.2)						
6.5.3	Are storage tanks located in the open air sited away from buildings and structures that may prevent an adequate flow of air for ventilation? (5.5.3)						
6.5.4	Is care taken when siting new tanks or structures in the vicinity of existing tanks, that conditions are not created that may be conducive to the accumulation of any released flammable vapours? (5.5.4)						
6.5.5	Has consideration been given to the possible release of flammable vapours from vent and fill lines and dip tube connections? (5.5.5)						
6.5.6	Are vents not less than the diameter of the filling or discharge line and not less than 25mm in diameter? (5.5.6)						
6.5.7	Are vent outlets located at least 3m but not more than 6m above ground level, or 1m above the top of the tank, whichever is the higher and discharge to a safe location in the open air at least 3m clear of window and door openings? (5.5.7)						
6.5.8	Is the vent discharge point at least 1m higher than the top of the delivery tanker in the case of gravity delivery? (5.5.8)						
6.5.9	If delivery is by pump, are high level alarms fitted to the tank or pre-set pump metering used? (5.5.9)						
6.5.10	Are ventilation pipes adequately secured? (5.5.10)						

		Yes	No	N/A	Action required	Due date	Sign on completion
6.5.11	Is a flame arrester installed at the vent outlet of any tank containing a liquid with a flashpoint of 21℃ or less? (A flame arrester should not be fitted where a pressure-vacuum vent valve is provided.) (5.5.11)						
6.5.12	Are flame arresters inspected regularly to ensure that they have not been obscured by paint or become obstructed, for example by polymerised materials? (5.5.12)						
6.5.13	In addition to vents designed to cope with pressure fluctuations during normal operations, are additional measures provided to relieve excess pressure as a result of a fire? (5.5.13)						
6.5.14	Is specialist advice sought regarding the provision of emergency pressure relief? (5.5.14)						
6.6	**Ignition (section 6)**						
6.6.1	Are all sources of ignition eliminated from the area of the tanks as far as practicable and temperatures of surfaces maintained well below the auto-ignition temperature of the liquids being stored? (5.6.1)						
6.6.2	Is smoking prohibited in all external areas where flammable liquids are used or stored and are prominent notices to this effect displayed? (5.6.2)						
6.6.3	Do the risk assessments undertaken for open air tank storage areas seek to mitigate the hazards associated with motor vehicles being introduced into the proximity? (5.6.3)						
6.6.4	Is electrical equipment and wiring certified as suitable for use within the zone in which the flammable liquid is being stored or processed? (5.6.4)						
6.6.5	Is there an adequate level of lighting (at least 50 lux) for safe working at all times? (5.6.5)						
6.6.6	Has the potential hazard of ignition due to a build-up of static electricity during movement or transfer of flammable liquids been assessed and precautions taken to eliminate it? (5.6.6)						
6.6.7	Are all metal tanks, associated extraneous pipework and fittings used for handling flammable and highly flammable liquids electrically bonded and earthed? (5.6.7)						
6.6.8	Is the bonding and earthing subject to an annual continuity test with suitable records being kept? (5.6.8)						
6.6.9	Is care taken to ensure satisfactory electrical bonding between flexible hoses and adjacent conventional pipework? (5.6.9)						
6.6.10	Is an earth lead for connection to the tanker provided for attachment before filling operations commence? (5.6.10)						
6.6.11	Does the tank filling line extend below the lowest normal operating level of the tank to minimise the generation of static electricity during filling operations? (5.6.11)						
6.6.12	Are heated tanks and their equipment constructed to an appropriate standard? (5.6.12)						
6.6.13	For economy as well as safety, is the heating of tanks kept to the minimum compatible with effective working practices? (5.6.13)						

		Yes	No	N/A	Action required	Due date	Sign on completion
6.6.14	Does tank heating equipment incorporate duplicate temperature sensors and thermostats and a high temperature limit device? (5.6.14)						
6.6.15	Is any vessel containing internal heating elements fitted with duplicate low liquid level alarms and cut-outs to prevent the heating elements being exposed to vapours within the tank? (5.6.15)						
6.6.16	Are temperature probes, thermostats and associated control equipment tested as part of the periodic maintenance programme for the installation? (5.6.16)						
6.6.17	If a drain pipe is fitted at a level lower than the heating coil or element, is it fitted with a closed valve and a blanking plate to deny its use during normal operations? (5.6.17)						
6.6.18	Are tanks only drained following cooling of the contents to ambient temperature? (5.6.18)						
6.6.19	Where a water layer cannot be avoided, is the heating system incapable of raising the temperature above 100˚C? (5.6.19)						
6.6.20	Where trace heating of pipework is necessary, are vent pipes and flame arresters also heated? (5.6.20)						
6.6.21	Is insulation of tanks or pipes of non-combustible material? (5.6.21)						
6.6.22	Where trucks have to be used in a zone in which a flammable vapour may be present, are they certified to the appropriate electrical zoning standard? (5.6.22)						
6.6.23	Are roadways sufficiently wide to permit safe manoeuvring of any vehicle requiring access to areas in the vicinity of storage tanks? (5.6.23)						
6.6.24	Are suitably positioned barrier rails positioned to minimise the risk of impact damage to bunds, pipework and associated fittings? (5.6.24)						
6.6.25	Are battery-powered trucks charged safely outside hazard zones in which a hazardous atmosphere may be present? (5.6.25)						
6.6.26	Are the gas cylinders of LPG fuelled vehicles changed away from the vicinity of storage tanks and other areas where highly flammable or flammable liquids are stored or used? (5.6.26)						
6.6.27	When planning the site for positioning a flammable liquid storage tank, is the possibility of deliberate fire raising considered as part of the fire risk assessment and a check made to ensure that there are adequate security precautions against arson and vandalism? (5.6.27)						
6.6.28	Is the area immediately surrounding a flammable liquid storage tank kept free from combustible materials, including waste, weeds and dried vegetation? (5.6.28)						
6.7	**Containment (section 7)**						
6.7.1	Are tanks constructed in compliance with a recognised standard with the materials used being compatible with the liquids being stored? (5.7.1)						
6.7.2	Is particular care paid to the protection of tanks constructed of glass reinforced plastic or similar materials to ensure that they maintain their integrity in the event of a fire? (5.7.2)						

		Yes	No	N/A	Action required	Due date	Sign on completion
6.7.3	Where access is provided for personnel wearing protective clothing and breathing apparatus, is the inside diameter of the manhole at least 600mm? (5.7.3)						
6.7.4	Where tanks are compartmented, is it ensured that incompatible materials are not stored in the same tank? (5.7.4)						
6.7.5	To prevent corrosion, is protective coating provided by paints or other products selected and applied in compliance with a recognised standard? (5.7.5)						
6.7.6	Where necessary, is there provision for the removal of accumulated water with drainage being protected by two in-line valves? (5.7.6)						
6.7.7	Are tanks installed on foundations designed to support the weight of the tank together with a full capacity of the most dense material that is likely to be stored within it? (5.7.7)						
6.7.8	Are tanks secured to their supports or weighted to avoid floatation in the event of flooding or spillage of liquid into the bund? (5.7.8)						
6.7.9	Where tanks are raised above ground level in bunds are their supports fire resistant to a 2 hour standard? (5.7.9)						
6.7.10	Where plastic tanks are used are their bases fully supported to prevent the risk of structural failure? (5.7.10)						
6.7.11	Have tanks below ground adequate foundations and supports, secure anchorage and appropriate corrosion prevention? (5.7.11)						
6.7.12	Is the space around tanks below ground backfilled with pea gravel or similar inert material with small particle size to avoid damaging the coating of the tank? (5.7.12)						
6.7.13	Are the locations of underground tanks marked prominently to prevent damage by traffic above? (5.7.13)						
6.7.14	Are secondary containment areas, or bunds, provided to retain leakage, guard against the risk of pollution and contain a possible flowing liquid fire? (5.7.14)						
6.7.15	Do bunds incorporate an impervious sill or low wall, at least 150mm high? (5.7.15)						
6.7.16	Do bunds have a capacity of not less than 110% of the contents of the largest container in the bund or 25% of the aggregate storage capacity of the containers, whichever is greater? (5.7.16)						
6.7.17	Do bunds have a base and walls which are impermeable to oil and water and treated with a proprietary sealing product where necessary to maintain this property? (5.7.17)						
6.7.18	Do bunds have a base and walls which are not penetrated by any drain pipe, valve or opening? (5.7.18)						
6.7.19	Where it is necessary for a fill or draw-off pipe to pass through the base or wall of the bund, is the junction between the pipe and the base or wall adequately sealed to prevent the escape of flammable liquid or water? (5.7.19)						
6.7.20	Are accumulations of rainwater pumped out of the bund periodically? (5.7.20)						

		Yes	No	N/A	Action required	Due date	Sign on completion
6.7.21	When designing a bund, is consideration given to minimising the surface area of any spillage while at the same time maintaining the height of the bund walls at a level at which access can be gained for firefighting? (5.7.21)						
6.7.22	Are tanks and bunds positioned so as to minimise the risk of damage by impact as far as practicable? (Where necessary, sills or bollards should be provided to minimise vehicular damage.) (5.7.22)						
6.7.23	Where there are multiple tanks in bunds, are these separated by suitable distances and low intermediate walls, typically half the height of the bund? (5.7.23)						
6.7.24	Are all parts of the tanks readily accessible to enable leakages to be easily identified? (5.7.24)						
6.7.25	Are tanks positioned so as not to be located one above another? (5.7.25)						
6.7.26	Where a tank with rigid integral bunding is considered to be a tank within a tank and no additional bunding is provided, is an intrinsically safe monitoring system incorporated into the design? (5.7.26)						
6.7.27	Are pumps located inside bunds on concrete bases in the open air, so as to be above the level of the bund walls? (5.7.27)						
6.7.28	Is pipework installed above ground level where it can easily be inspected and maintained? (5.7.28)						
6.7.29	Is the pipework constructed of metal with all elements of the installation, including valves, seals and flange gaskets, compatible with the contents of the tank to ensure the integrity of the system? (5.7.29)						
6.7.30	Is every pipe entering a tank provided with a suitable valve to allow it to be isolated? (5.7.30)						
6.7.31	Are valves provided, where necessary, to prevent the backflow of products or process materials into the tank? (5.7.31)						
6.7.32	Is pipework routed carefully and suitable precautions taken to protect the system, especially where gantries are involved? (5.7.32)						
6.7.33	Is pipework marked prominently in accordance with BS 1710 to indicate the contents and direction of flow? (5.7.33)						
6.7.34	Are valves labelled as to their function and, where necessary, their method of operation? (5.7.34)						
6.7.35	Are valves exercised and tested periodically to ensure that they will work correctly and effectively in an emergency? (5.7.35)						
6.7.36	Are measures installed to prevent excessive pressure building up as a result of the thermal expansion of liquid trapped in pipework or between shut-off valves? (5.7.36)						
6.7.37	Are appropriate measures provided for movement between tanks and supports? (5.7.37)						

		Yes	No	N/A	Action required	Due date	Sign on completion
6.7.38	Has consideration been given to minimising the diameter and length of the pipes to reduce the potential for spillage in case of an accident? (5.7.38)						
6.7.39	Where it is necessary to lay pipework beneath ground, is it laid in a masonry or concrete lined trench and protected by load bearing covers? (5.7.39)						
6.7.40	Is the pipework inspected periodically, with the results being recorded, especially in the region of joints, and access available for any valves below ground level? (5.7.40)						
6.7.41	Are flexible hoses only used above ground level where vibration is a problem, and installed, supported and maintained as directed by the manufacture? (5.7.41)						
6.7.42	Is tank filling only undertaken by an authorised person? (5.7.42)						
6.7.43	Are tank filling connections, together with those for emptying, dipping and venting, located at least 4m from any source of ignition, building opening, trench or depression in the ground? (5.7.43)						
6.7.44	Are filling points accessible by road tankers without the need for reversing the vehicles and not normally accessible to other road vehicles or pedestrians? (5.7.44)						
6.7.45	Do fill lines enter the tank at the top? (5.7.45)						
6.7.46	Are tanks containing highly flammable and flammable liquids fitted with a proprietary overfill prevention system incorporating a means of shutting off the flow and raising an alarm at a remote area that is permanently manned when refilling operations are taking place? (5.7.46)						
6.7.47	Is the connection point for filling or discharging outside the bund wall and close to the tanker stand to minimise the length of the connections? (5.7.47)						
6.7.48	Are the filling operations always under the control of the receiving organisation? (5.7.48)						
6.7.49	Is filling undertaken using a fixed pump on site rather than a vehicle mounted pump to allow all equipment on the vehicle to be switched off during the operation? (5.7.59)						
6.7.50	Are filling points equipped with non-return valves located close to the shut-off valve to minimise any spillage if the shut-off valve fails to seal? (5.7.50)						
6.7.51	Is spillage from making and breaking connections collected in a drip tray and disposed of safely? (5.7.51)						
6.7.52	Are filling lines capped when not in use, with locking caps fitted in position? (5.7.52)						
6.7.53	Is each tank fitted with a liquid level device. Dial gauges are preferable to sight gauges? (5.7.53)						
6.7.54	Are dial or electronic gauges calibrated on installation and periodically thereafter as part of the tank inspection programme? (5.7.54)						
6.7.55	Is physical dipping of tanks avoided if possible, in order to minimise the risk of ignition by static electricity and to reduce the likelihood of insecure replacement of the dip cap? (5.7.55)						

		Yes	No	N/A	Action required	Due date	Sign on completion
6.7.56	Are appropriate quantities of suitable materials available to retain and absorb spillages, with staff trained in the safe use and disposal of these materials? (5.7.56)						
6.8	**Exchange (section 8)**						
6.8.1	Is each flammable and highly flammable liquid considered in turn and possible non-combustible or aqueous based alternatives considered? (5.8.1)						
6.9	**Separation (section 9)**						
6.9.1	Are tanks located so as not to be on the roofs of buildings? (5.9.1)						
6.9.2	Are tanks above ground level located in a well ventilated position, separated from buildings and structures, process areas and the site boundary but in a position with easy accessibility by the emergency services? (5.9.2)						
6.9.3	Are separation distances determined with regard to the capacity of the tanks? (5.9.3)						
6.9.4	Are small tanks grouped together so that the aggregate capacity of the group is not in excess of 8000m^3 and the tanks are all accessible for firefighting purposes? (5.9.4)						
6.9.5	Has the insurer been consulted regarding the separation of groups of 'small' tanks and 'large' tanks from site boundaries, buildings, process areas, fixed sources of ignition and other hazardous materials? (5.9.5)						
6.9.6	For the purpose of determining the separation distances from site boundaries, buildings, process areas and fixed sources of ignition, are a group of small tanks considered to be a single tank? (5.9.6)						
6.9.7	Where it is necessary to site tanks underground, are they outside the building line? (5.9.7)						
6.9.8	Where underground tanks are sited in a position where they are likely to be subjected to undue loadings from any cause, is the area fenced off or are the tanks located in a pit constructed of reinforced concrete with a reinforced concrete slab cover? (5.9.8)						
6.9.9	Is the installation of tanks in areas with a high water table avoided? (5.9.9)						
6.9.10	Are bunds, interceptors, loading and unloading facilities, as well as the tanks and associated valves and pipework regularly inspected and maintained, on a risk assessed basis, by a competent person? (5.9.10)						
6.9.11	Are staff aware that empty tanks may still contain significant traces of liquid and/or flammable vapours and thus be extremely hazardous? (5.9.11)						
6.9.12	When a decision has been made as to whether a tank, is to be taken out of service by being demolished or be cleaned and maintained for possible future use, is a risk assessment undertaken to identify hazards associated with the intended course of action? (5.9.12)						
6.9.13	When decommissioning and/or demolishing a tank is the vessel physically isolated from any plant, process or other storage vessel? (5.9.13)						
6.9.14	Following isolation, is the tank emptied as much as possible, vented, cleaned and gas freed following the procedures set out in the HSE Guidance note CS 15? (5.9.14)						

		Yes	No	N/A	Action required	Due date	Sign on completion
6.9.15	Are tanks to be decommissioned for possible future use cleaned or filled with water or an inert gas such as nitrogen? (5.9.15)						
6.9.16	Is all work undertaken on decommissioning tanks carried out under a permit to work system? (5.9.16)						
6.9.17	Does the decommissioning of underground storage tanks follow the guidance set out by the Energy Institute? (5.9.17)						
6.10	**Fire protection (section 10)**						
6.10.1	Are the fire protection measures for areas where flammable and highly flammable liquids are stored, handled or used proportionate to the risk and based on the findings of the fire risk assessments carried out in compliance with fire safety legislation and DSEAR? (5.10.1)						
6.10.2	Are all storage facilities, including external areas in the immediate vicinity of storage tanks, fitted with a manually operated fire alarm system that will sound and be audible in all areas of the storage facility above the background noises? (5.10.2)						
6.10.3	Are the fire alarm and communications systems intrinsically safe and appropriate for hazard zones in which they are installed? (5.10.3)						
6.10.4	Has consideration been given to protecting storage tanks with a suitably designed fixed foam or water spray fire protection system? (5.10.4)						
6.10.5	Are sufficient water supplies for cooling tanks available? (5.10.5)						
6.10.6	Is effective liaison maintained with the fire and rescue authority? (5.10.6)						
6.10.7	Is a suitable number of appropriate portable fire extinguishers, approved and certificated by an independent, third-party certification body, provided and maintained? (5.10.7)						
6.11	**Environmental considerations (section 11)**						
6.11.1	Does the storage of flammable and highly flammable liquids follow environmental legislation and guidance (which varies according to the region of the UK and the regulatory agency involved)? (5.11.1)						
6.11.2	Are the quantities of highly flammable and flammable liquids used monitored and compared with those delivered with any variations being investigated? (5.11.2)						
6.11.3	Are suitable fire water run-off and retention facilities provided in consultation with the fire and rescue service? (5.11.3)						
6.11.4	Has additional information regarding the design, installation and maintenance of underground storage tanks been sought from the Environment Agency or equivalent organisations in Scotland and Northern Ireland? (5.11.4)						
6.11.5	Have vapour balancing systems been provided for new installations? (5.11.5)						

7 References

1. The Control of Major Accident Hazard Regulations 1999 (COMAH), SI 1999 No 743, as amended by the Control of Major Accident Hazard Amendment Regulations 2005, SI 2005 No 1088, The Stationery Office.
2. The Petroleum (Consolidation) Act, 1928 c.32, The Stationery Office.
3. The Control of Substances Hazardous to Health Regulations 2002 (COSHH), SI 2002 No 2677, (as amended), The Stationery Office.
4. Chemicals (Hazard Information and Packaging for Supply) Regulations 2002, (CHIPS 3), SI 2002 No 1689, as amended by the Chemicals (Hazard Information and Packaging for Supply) (Amendment) Regulations 2005, SI 2005 No 2571. The Stationery Office.
5. The Health and Safety (Safety Signs and Signals) Regulations 1996, SI 1996 No 341, The Stationery Office.
6. The Oil Pollution (Oil Storage) (England) Regulations 2001, SI 2001 No 2954, The Stationery Office.
7. RC55: *Recommendations for fire safety in the storage, handling and use of highly flammable and flammable liquids: General principles*, 2014 Fire Protection Association.
8. RC56: *Recommendations for fire safety in the storage, handling and use of highly flammable and flammable liquids: Storage containers other than external fixed tanks*, 2014 Fire Protection Association.
9. Regulatory Reform (Fire Safety) Order 2005, SI 2005 No 1541, The Stationery Office.
10. The Fire (Scotland) Act 2005, asp 5. The Stationery Office.
11. Fire Safety (Scotland) Regulations 2006, Scottish SI 2006 No 456. The Stationery Office.
12. Fire and Rescue Services (Northern Ireland) Order 2006, SI 2006 No 1254 (NI9), The Stationery Office.
13. Fire Safety Regulations (Northern Ireland) 2010, SI 2010 No 325 (NI), The Stationery Office.
14. Dangerous Substances and Explosive Atmospheres Regulations 2002 SI 2002 No 2776, The Stationery Office.
15. BS EN 60079-10-1: 2009: *Explosive atmospheres. Classification of areas. Explosive gas atmospheres*, British Standards Institution.
16. Directive 1992/69/EEC, *Classification, packaging and labelling of dangerous substances*, The Stationery Office.
17. HSG 71: *Storage of packaged dangerous substances*, 2009, Health and Safety Executive.
18. RC42: *Recommendations for fire safety of unattended processes*, 2011, Fire Protection Association.
19. *Business resilience: A guide to protecting your business and its people*, 2005, Fire Protection Association.
20. The ROBUST software (Resilient Business Software Toolkit) may be found at https://robust.riscauthority.co.uk
21. Dangerous Substances (Notification and Marking of Sites) Regulations 1990, SI 1990, No. 304 (as amended), The Stationery Office.
22. BS 1722-12: 2006: *Fences. Specification for steel palisade fences*, British Standards Institution.
23. RC7: *Recommendations for hot work*, 2012, Fire Protection Association.
24. HSG 51: *Storage of flammable liquids in containers*, 1998, Health and Safety Executive.
25. Electricity at Work Regulations 1989, SI 1989 No 635, The Stationery Office.

26. BS EN 60079-14: 2008: *Explosive atmospheres. Electrical installations design, selection and erection*, British Standards Institution.
27. BS 7430: 2011: *Code of practice for protective earthing of electrical installations*, British Standards Institution.
28. BS 799-5: 2010: *Oil burning equipment. Carbon steel storage tanks*. Specification. British Standards Institution.
29. HSG 113, *Lift trucks in potentially flammable atmospheres*, Health and Safety Executive, 1996.
30. RC48: *Arson prevention. The protection of premises from deliberate fire raising*, 2010, Fire Protection Association.
31. *The Prevention and Control of Arson*, Third edition 2012, Fire Protection Association.
32. BS EN 12285-2: 2005: *Workshop fabricated steel tanks. Horizontal cylindrical single skin and double skin tanks for the aboveground storage of flammable and non-flammable water polluting liquids*, British Standards Institution.
33. BS EN 14015: 2004: *Specification for the design and manufacture of site built, vertical, cylindrical, flat-bottomed, above ground, welded, steel tanks for the storage of liquids at ambient temperature and above*, British Standards Institution.
34. BS EN 13923: 2005: *Filament-wound FRP pressure vessels. Materials, design, manufacturing and testing*, British Standards Institution.
35. BS EN ISO 12944 (various parts): *Paints and varnishes. Corrosion protection of steel structures by protective paint systems*, British Standards Institution.
36. BS EN ISO 14713 (various parts): *Zinc coatings. Guidelines and recommendations for the protection against corrosion of iron and steel in structures*, British Standards Institution.
37. BS 1710: 1984: *Specification for identification of pipelines and services*, British Standards Institution.
38. HSG176: *The storage of flammable liquids in tanks*, 1998, Health and Safety Executive.
39. CS15: *Cleaning and gas freeing of tanks containing flammable residues*, 1985, Health and Safety Executive.
40. *Design, construction, modification, maintenance and decommissioning of filling stations*, 3rd Edition, 2011, Energy Institute.
41. BS 5839-1: 2013: *Fire detection and fire alarm systems for buildings. Code of practice for design, installation, commissioning and maintenance of systems in non-domestic premises*, British Standards Institution.
42. BS 5306-8: 2012: *Fire extinguishing installations and equipment on premises. Selection and positioning of portable fire extinguishers. Code of practice*, British Standards Institution.
43. BS 5306-3: 2009: *Fire extinguishing installations and equipment on premises. Commissioning and maintenance of portable fire extinguishers. Code of practice*, British Standards Institution.
44. *Pollution Prevention Guideline: PPG 2: Above Ground Oil Storage Tanks*, 2010, published jointly by the Environment Agency for England and Wales, the Scottish Environment Protection Agency and the Environment and the Northern Ireland Environment Agency.

RISCAuthority

administered by FPA Fire Protection Association

Fire Protection Association
London Road
Moreton in Marsh
Gloucestershire GL56 0RH
Tel: +44 (0)1608 812500
Email: info@riscauthority.co.uk
Website: www.riscauthority.co.uk

RC57 (formley RC20C) First published 1997 Version 02

Printed by: