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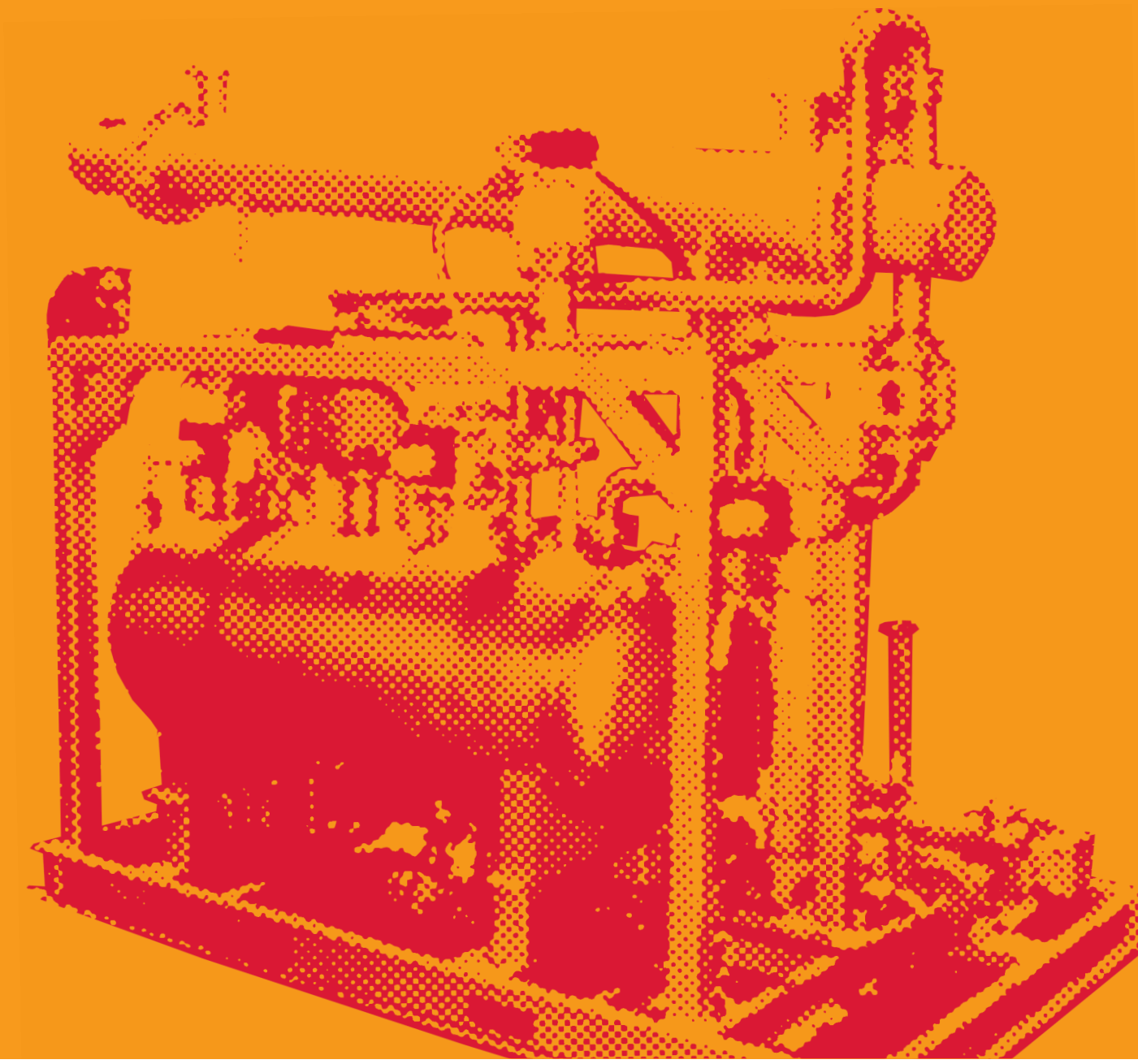
Risk Control

Recommendations for fire safety for waste solvent recovery plants



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CONTENTS

SCOPE

These recommendations outline the general fire safety requirements for waste solvent recovery systems used in the workplace.

This document addresses modular type units of the distillation and carbon absorption types but excludes high volume distillation processes common to the petrochemical industry.

SYNOPSIS

These recommendations provide practical guidance regarding the management and use of large and small scale solvent recovery plants using distillation and carbon absorption, the two most commonly encountered processes.

Precautions in the use and following shutdown periods are set out, together with advice regarding fire safety management and fire suppression systems should an incident occur.

DEFINITIONS

Absorption
The process by which one substance, such as a solid or liquid, takes up another substance, such as a liquid or gas, through minute pores or spaces between its molecules.

Adsorption
The adhesion of atoms, ions or molecules from a gas, liquid or dissolved solid onto a surface.

Distillation
The extraction of the volatile components of a mixture by the condensation and collection of the vapours that are produced as the mixture is heated.

Flashpoint
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 (BS EN 60079-10-1: 2009: **Explosive atmospheres. Classification of areas. Explosive gas atmospheres** (ref. 1)).

Pervaporation
A process, which may be undertaken under pressure, involving purification by passing a mixture, such as an alcohol and water, through a porous membrane that holds back one or more of the components. The membrane can be considered to be a form of filter or strainer.

INTRODUCTION

Solvent recovery operations may be found in any business where solvents are used. Recovering used solvent may substantially reduce wastage, and the costs associated with the purchase of raw materials and the disposal of waste products.

The need to meet strict environmental regulations and the economic benefits of recovering and re-using solvents has resulted in the increased use of solvent recovery equipment in the workplace, for example to recover an expensive process component for re-use or for removal of a by-product from wastewater to meet effluent regulations. The size and type of the equipment or plant required will vary in relation to the volume and nature of the waste stream that is intended to be handled.

Depending on the waste stream, the process may involve:

- distillation;
- liquid/liquid extraction;
- absorption;
- adsorption;
- steam stripping; or
- a combination of these processes.

This document focuses on the distillation and carbon absorption processes. The recovery of solvent from liquid waste streams usually involves distillation while recovery from vapour streams typically is carried out utilising a carbon bed absorption process.

Distillation involves the liquid waste being fed into a still. The liquid is then heated above the boiling point of the solvent to be recovered and the liberated solvent vapours are cooled and the condensate retained. Recovery is normally undertaken as a batch process but may form a continuous operation. Residual liquids may be further processed or sent for disposal. Stills may have capacities from several litres to several hundred litres; some operate under a vacuum which accommodates distillation at lower temperatures.

Solvents that can be recovered by distillation include polluted paint thinners, alcohols, toluene, acetone, ketones and low boiling point alkanes.

Carbon bed absorption involves solvent laden vapours being passed through a vessel containing a bed of activated carbon. Solvent is absorbed by the carbon bed as the vapours pass through and steam is subsequently used to recover the solvent from the bed, with the vapours being passed through a condenser where the solvent and water are separated and the solvent recovered. Two or more carbon bed vessels are normally used to allow absorption and desorption phases to be carried out concurrently.

While national standards are available for the manufacture of various components for solvent recovery systems, for example the pipes, valves, pressure vessels and electrical equipment for use in hazardous atmospheres, there is no definitive British Standard addressing the construction of the plant. Some best practice and guidance documents are, however, available. These include the **FM Global Property Loss Prevention Data Sheet 7-2: Waste solvent recovery** (ref. 2) and the **Engineering Data Sheet 4-16: Solvent recovery equipment** issued by the Ontario Ministry of Labour (ref. 3).

As many solvent recovery plants involve the handling and processing of flammable and highly flammable liquids, care needs to be taken to plan effective management, use and maintenance of the equipment. Additional information regarding flammable liquids is available in RISCAuthority documents **RC20: Recommendations for fire safety in the storage and use of highly flammable and flammable liquids: Part 1: General principles** and **Part 2: Storage in drums, cans and containers other than external fixed tanks** (refs 4 and 5).

RECOMMENDATIONS

1. Compliance with fire safety legislation

Fire safety legislation relates to solvent recovery plants and associated processes involving flammable and highly flammable liquids as well as to other areas of the workplace. The hazards associated with the suitability and siting of the equipment, the separation from surrounding areas, spill control, ignition control, storage, operator training and the handling and storage of solvents should all be considered as key elements of the fire risk assessment for the workplace.

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 6-9). This assessment should include the solvent recovery and associated processes.

1.2 The scope of the risk assessment should address the implications of idle time, maintenance, routine servicing and cleaning operations.

1.3 As well as the installation itself and the operators of the equipment, the assessment should also consider staff remote from the process area who may be affected by smoke and heat in the event of a fire. The implications for property protection and business continuity should also feature prominently in the assessment.

1.4 An assessment should also be undertaken in accordance with the **Dangerous Substances and Explosive Atmospheres Regulations 2002** (DSEAR) (ref. 10).

1.5 Risk assessments should be the subject of periodic review, including at the time when any changes to the process, the products involved, or the acceptance of new materials or waste streams are being considered.

2. Business continuity

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

2.1 In commercial premises where solvent recovery is undertaken, the fire hazards and thus the threat to the business are increased if the process is allowed to take place when staff are absent. The equipment should therefore not be left operating when the premises are unattended unless it has been specifically designed for this purpose.

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. 11). 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.

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

2.4 Consideration may be given to applying commercially available computer programmes, such as the **ROBUST** software (**Resilient Business Software Toolkit**) that is available free of charge (ref. 12), or other appropriate product, to develop and check the adequacy of the plan.

3. Fire safety management

3.1 The fire safety management of the facility will rely on the following important records and information which will usually be provided by the supplier at the time of installation and must be retained and observed, together with appropriate records:

Process type/function	Potential fire and explosion hazards
Solvent recovery units of the distillation type	• Fire and explosion hazard associated within the actual process equipment. • Fire and explosion hazard in equipment rooms in the event of a release of vapour or heated liquid. • Leaks of solvent from vessels due to over-pressurisation or mechanical damage. • Possible damage to important process equipment in the immediate vicinity of the solvent recovery unit. This could impact adversely on business continuity.
Solvent recovery units of the carbon absorption type	• The explosion hazard within the absorption tanks is considered minimal although explosion hazards may exist in rooms housing the units if there is a release of flammable vapour, such as from ducting or fan housings. • A fire hazard exists within the absorption units. Hot spots may develop under standby conditions which may flame-up when the flow of air is resumed. Some products being recovered may also be prone to heating to auto ignition.
Solvent laden liquids for recovery	Liquids to be recovered may exhibit flammable properties depending on the solvent content of the mixture.
Recovered solvent	Recovered solvents will present similar fire and explosion hazards to those associated with the use, handling and storage of flammable liquids generally. The hazard and subsequent storage arrangements may vary depending on the flammable properties of the solvent recovered.
Use of incorrect recovery equipment	The use of non-flammable solvent recovery equipment to recover flammable solvent must be avoided, due to the increased risk of fire and explosion.

Table 1: Potential fire hazards

- a handbook for the management and operation of the system that incorporates the hazards associated with the equipment and recommendations for its safe use;
- recommendations and requirements for inspection and maintenance of the system including safety systems, correct inspection/maintenance functions and their frequencies; and
- records of inspections of electrical installations and equipment including special electrical equipment used in identified hazard zones.

3.2 All relevant staff should be trained so as to have a clear understanding of:

- the hazards associated with the solvent recovery system;
- the principles of VICES (see section 6);
- both the normal daily operation and emergency procedures, including the safe recovery of spillages of highly flammable and flammable substances and their safe disposal.

3.3 Good liaison is often established by inviting the fire and rescue service to visit the site and be involved in an emergency evacuation exercise of the premises.

3.4 Information should be provided for the fire and rescue service at a prominent location, normally at the entrance to the site, to indicate:

- the layout of the site;
- the location of the solvent recovery plant;
- the location of emergency shutdown points for the manufacturing processing operations and the solvent recovery plant;
- the nature of the automatic fire suppression system(s) and the location of their controls;
- contact details for specialist staff who may need to be consulted; and
- the location of hydrants, rising mains or other sources of water for firefighting purposes.

3.5 In the event of a fire, experienced member(s) of staff should be designated to meet the fire and rescue service on their arrival at the site.

3.6 Staff should be made aware of the hazards of deliberate fire raising, for which either colleagues or intruders may be responsible.

3.7 Flammable liquids and 'empty' containers should not be accessible to intruders; suitable security measures should be in place.

3.8 Where solvent recovery equipment is linked to thermal oxidation plant then the recommendations set out in RC53: **Recommendations for fire safety in the use of thermal oxidation plant** (ref. 13) should be observed.

4. VICES

The HSE guidance in booklet HS(G)51 (ref. 14) suggests the use of the acronym VICES to help apply five basic principles which ensure that appropriate care is taken regarding the use and storage of any flammable or highly flammable liquid.

The acronym may be explained as follows:

V – Ventilation (see section 4.1)

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

I – Ignition (see section 4.2)

- Have all possible ignition sources been removed?

C – Containment (see section 4.3)

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

E – Exchange (see section 4.4)

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

S – Separation (see section 4.5)

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

4.1 Ventilation

4.1.1 Depending on the size and type of recovery equipment, adequate ventilation should be provided to prevent the accumulation of flammable vapours above the lower explosive limits of the most hazardous solvent likely to be present. Continuous high and low level mechanical ventilation may be required for areas housing larger recovery units.

4.1.2 Where hot spots or auto-heating may develop in carbon absorption units during standby, airflows should be maintained for a period as determined by a risk assessment to dissipate any heat generated.

4.2 Ignition protection

4.2.1 All potential ignition sources should be identified and suitably mitigated by:

- implementation of suitable hot work controls;
- control of static electricity where required, such as earthing and bonding, in accordance with BS 5958-1: **Code of practice for control of undesirable static electricity. General considerations** (ref. 15);
- identification of hazardous areas in accordance with BS EN 60079-10-1 (ref. 1) and appropriate zoning to ensure that appropriate electrical equipment is provided; and
- other potential ignition sources such as the potential for open flames, hot surfaces and friction should also be identified and addressed.

4.3 Containment (spill control)

4.3.1 As is the case with most flammable liquid risks, suitable means for controlling and cleaning up spills should be provided, together with provisions for the safe disposal of waste.

4.3.2 Minor leaks should not be tolerated as being part of the process. When even a small leak is discovered, intervention and repair should be instigated immediately.

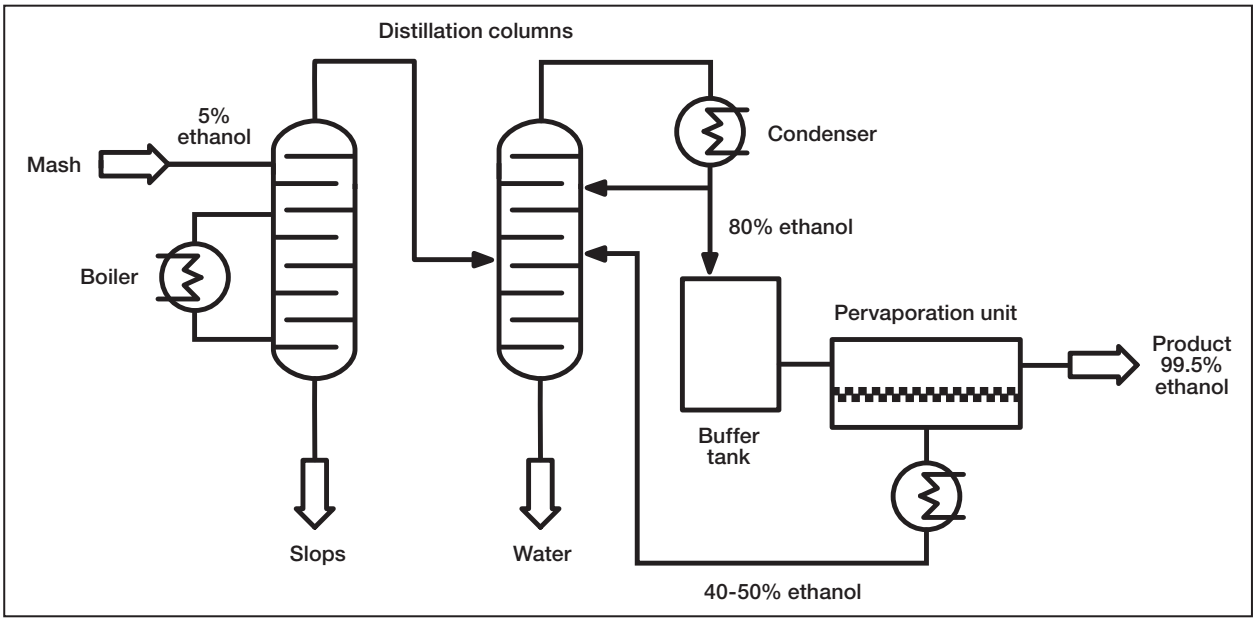

Figure 1: Simplified ethanol distillation recovery plant

4.4 Exchange

4.4.1 At the outset, attention should always be given to eliminating flammable and highly flammable liquids from the workplace wherever possible. Serious consideration should be given to the need for the use of such liquids in the process and the possibility of replacing them with non-flammable liquids as alternatives – or at least with those having a flashpoint above 55°C.

4.5 Separation

4.5.1 The scale of solvent recovery equipment varies widely in terms of the capacity or flow rate. The siting of the equipment and need for fire-rated separation from surrounding areas will be influenced by the solvent capacity or flow rate of the unit and should be subject to risk assessment. Fire safety provisions for solvent recovery equipment should be proportionate to the type and solvent capacity of the equipment. In many cases, stricter requirements are likely to apply to units processing more than 20 litres of solvent in a single vessel, particularly where these are distillation units.

4.5.2 Distillation units with a capacity of more than 20 litres and carbon absorber processes should be located outdoors, at least 10m away from buildings and plant, in a detached dedicated building. Where this is not possible, the equipment may be located in a dedicated fire compartment separated from adjacent areas by construction providing at least 60-minutes' fire resistance.

4.5.3 Where located in a 60-minute fire compartment that is part of a building, the compartment should have at least one outside wall. The need for any openings into adjacent areas should be carefully assessed, but where these are necessary, they should be provided with doorsets providing at least one-hour fire resistance.

4.5.4 Explosion protection for the area in which the recovery plant is located should be considered in accordance with the findings of the assessment carried out in compliance with DSEAR (ref. 10).

4.5.5 Where small units are in use, for example those with less than 20 litres capacity, the application of the separation principles set out in 4.5.2 and 4.5.3 may be determined by the fire risk assessment to be excessive in relation to the risk in the surrounding area. In these cases the fire safety precautions adopted should be in accordance with the requirements of RISCAuthority recommendations RC20 Part 1 (ref. 4).

5. Operation – distillation systems

5.1 The design of distillation type equipment should include provisions for the monitoring of process conditions at a location that is permanently manned during working hours. Where the process is in an area that may be unmanned, it will be necessary for monitoring equipment to be duplicated at an appropriate permanently manned area.

5.2 Distillation type recovery equipment may be heated by steam or thermal oil. Where steam is supplied under pressure, a pressurised relief valve should be installed to operate at 5psi to 10psi above normal operating pressure. In these cases:

5.2.1 Pressure relief valves should be maintained in accordance with the manufacturer's instructions.

5.2.2 Piped vents should be fitted to the pressure relief valves and condenser vents with the pipes venting outside the building away from potential sources of ignition and so that the vapours will not re-enter the building.

5.2.3 Pipe vents outside the building should be fitted with flame arrestors.

5.2.4 The pipework should be designed to travel as directly as possible to the outside without passing through another fire compartment or be routed through a void area (such as between a ceiling and a floor above).

5.3 The tanks of waste and recovered solvents, together with the still vessel should be provided with high and low liquid level monitors that operate automatically to shut down the process safely when adverse conditions occur. The liquid level alarms should be monitored at an area that is permanently manned when the equipment is in use.

5.4 The still should have high temperature sensor(s) that will sound an alarm at the monitoring area and shut off heat supply should the temperature exceed a predetermined safe limit.

5.5 The cooling water to the still should be monitored with flow/pressure alarms set at predetermined safe levels. In the event of the water supply falling below the set criteria, the heating for the still should automatically be shut off and an alarm sound at the monitoring area.

5.6 For large scale processes, or those that operate with minimum supervision, serious consideration should be given to the provision of automatic detection of a leak of solvent vapour. Such detectors should be installed in accordance with BS 45544: **Workplace atmospheres. Electrical apparatus used for the direct detection and direct concentration measurement of toxic gases and vapours** or similar relevant standard. Detectors should operate to safely shut the process down at a concentration of about 10% of the minimum explosible limit of the flammable vapour concerned.

5.7 When the process is not operational, flammable vapour detection, automatic fire suppression systems and mechanical ventilation (where fitted) should remain operational.

6. Operation – carbon absorption systems

6.1 The concentration of flammable vapours entering the absorber bed should be managed to keep it well below the lower flammable or explosive limit of the most volatile solvent likely to be present. The concentration of vapours should not exceed 25% of the lower flammable limit of the most volatile solvent present or 50% where continuous gas detectors are in operation to provide automatic shut down of the equipment if this level is exceeded.

6.2 Suitable precautions should be taken to prevent auto-heating during extended shutdowns. These may include consideration being given to removing the carbon or inerting the absorbent bed using nitrogen or carbon dioxide. Keeping the bed wet or maintaining the airflow for ventilation are also valid options. Carbon monoxide analysers and automatic water spray provisions should be operational during shutdown periods.

6.3 Consideration should be given to providing fixed water spray nozzles inside the adsorbers over the carbon bed to wet down the bed in the event of excessive temperature or fire. Underbed flooding should not be used as this may cause solvents to float and cause the vapours within the vessel to accumulate to within the explosive limits.

6.4 The vessel in which the absorbant process is undertaken should be designed to be able to withstand the additional weight of wetting or fire extinguishing water.

6.5 The vessel should be provided with a drain line designed to operate automatically or by means of a liquid relief valve. The line should be a minimum of 50mm in diameter and lead to a safe drain point by as straight a route as possible so as not to be obstructed by any loose carbon granules or pellets.

6.6 Appropriate temperature records should be kept to monitor any increasing likelihood of self heating of the carbon bed over a period of time.

7. Fire protection

7.1 The installation of automatic fixed fire suppression systems is strongly recommended, especially if the facility is likely to run unattended. The fire suppression system should be designed to BS EN 12845: 2004 + A2: 2009: **Fixed firefighting systems. Automatic sprinkler systems. Design, installation and maintenance** (ref. 16) or other recognised standard and operate automatically as soon as a fire is detected. The installation should be designed so as to minimise the likelihood of an unwanted actuation.

7.2 Fixed fire suppression systems should be designed, installed and commissioned by an engineer with accreditation by an independent UKAS-accredited third party certification body.

7.3 Suppression systems should be tested and maintained according to the requirements of the relevant British Standard and/or the installer's recommendations by a competent engineer with accreditation by an independent UKAS-accredited third party certification body. Suitable records should be kept.

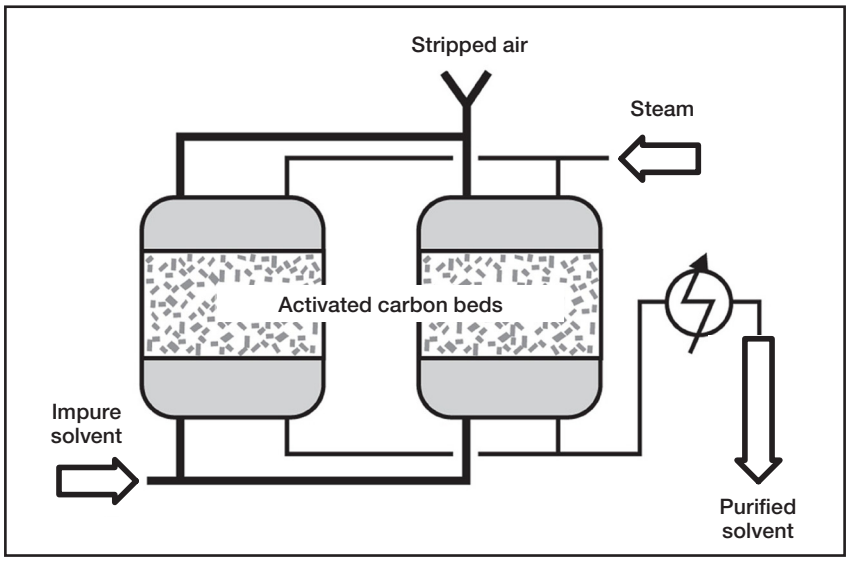

Figure 2: Simplified diagram of carbon absorption recovery plant

7.4 On operation of the fire suppression system, the process should automatically shut down and signalling be activated at any remote control point.

7.5 Arrangements should be in place for the prompt recommissioning of an automatic fire suppression system that has actuated. Back up supplies of extinguishing agents should be kept or arrangements made for their immediate replacement.

7.6 Following actuation of the fire suppression system, the process must not be left working unattended until:

- the automatic fire suppression system has been fully recommissioned; and
- the equipment has been inspected and found to be serviceable by a competent person; or
- appropriate repairs have been undertaken or replacement parts fitted by a competent person to render the equipment serviceable.

7.7 In addition to any automatic extinguishing system, a suitable number of appropriate portable fire extinguishers should be available and immediately accessible in the case of a fire. Such portable extinguishers should be approved and certified by an independent, third party certification body and be installed in accordance with BS 5306-8: **Fire extinguishing installations and equipment on premises. Selection and installation of portable fire extinguishers. Code of practice** (ref. 17) and inspected and maintained in compliance with BS 5306-3: **Fire extinguishing installations and equipment on premises. Commissioning and maintenance of portable fire extinguishers. Code of practice** (ref. 18).

7.8 Consideration should be given to installing an automatic fire detection and alarm system complying with BS 5839-1: 2002 + A2: 2008: **Fire detection and fire alarm systems for buildings. Code of practice for system design, installation, commissioning and maintenance** (ref. 19), designed, installed and maintained by an engineer with accreditation by an independent UKAS-accredited third party certification body.

7.9 In zoned hazardous areas, it may be necessary for fire detection systems and communications systems to be intrinsically safe and appropriate for the temperature and other conditions prevailing in the zone.

8. Checklist

		Yes	No	N/A	Action required	Due date	Sign on completion
8.1	**Compliance with fire safety legislation (section 1)**						
8.1.1	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? (1.1)						
8.1.2	Does the scope of the risk assessment address the implications of idle time, maintenance, routine servicing and cleaning operations? (1.2)						
8.1.3	Does the assessment consider staff remote from the process area who may be affected by smoke and heat in the event of a fire? (1.3)						
8.1.4	Do the implications for property protection and business continuity also feature prominently in the assessment? (1.3)						
8.1.5	Has an assessment also been undertaken in accordance with the Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR)? (1.4)						
8.1.6	Are the risk assessments the subject of periodic review, including at the time when any changes to the process, the products involved, or the acceptance of new materials or waste streams are being considered? (1.5)						
8.2	**Business continuity (section 2)**						
8.2.1	Are measures taken not to leave equipment operating when the premises are unattended unless it has been specifically designed for this purpose? (2.1)						
8.2.2	Has an emergency plan been drafted that addresses the implications of a fire, flood or other perceived disaster on all facets of the business model? (2.2)						
8.2.3	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? (2.2)						
8.2.4	Are tabletop exercises held periodically to test the effectiveness and suitability of the emergency plans? (2.3)						
8.2.5	Has consideration been given to applying commercially available computer programmes, such as the **ROBUST** software, or other appropriate product, to develop and check the adequacy of the plan? (2.4)						

		Yes	No	N/A	Action required	Due date	Sign on completion
8.3	**Fire safety management (section 3)**						
8.3.1	Are the following records and information which will usually be provided by the supplier at the time of installation retained and observed, together with appropriate records: • a handbook for the management and operation of the system? • recommendations and requirements for inspection and maintenance of the system? and • records of inspections of electrical installations and equipment? (3.1)						
8.3.2	Have all relevant staff been trained so as to have a clear understanding of the following: • the hazards associated with the solvent recovery system? • the principles of VICES (see section 6)? and • both the normal daily operation and emergency procedures? (3.2)						
8.3.3	Has good liaison been established by inviting the fire and rescue service to visit the site and be involved in an emergency evacuation exercise of the premises? (3.3)						
8.3.4	Has information been provided for the fire and rescue service at a prominent location to indicate the following: • the layout of the site? • the location of the solvent recovery plant? • the location of emergency shutdown points for the manufacturing/processing operations and the solvent recovery plant? • the nature of the automatic fire suppression system(s) and the location of their controls? • contact details for specialist staff? and • the location of hydrants, rising mains or other sources of water? (3.4)						
8.3.5	In the event of a fire, have experienced member(s) of staff been designated to meet the fire and rescue service on their arrival at the site? (3.5)						
8.3.6	Have staff been made aware of the hazards of deliberate fire raising, for which either colleagues or intruders may be responsible? (3.6)						
8.3.7	Is access to flammable liquids and ‘empty’ containers denied to intruders? (3.7)						
8.3.8	Where solvent recovery equipment is linked to thermal oxidation plant, are the recommendations set out in RC53: **Recommendations for fire safety in the use of thermal oxidation plant** observed? (3.8)						

		Yes	No	N/A	Action required	Due date	Sign on completion
8.4	**VICES (section 4)**						
8.4.1	**Ventilation**						
8.4.1.1	Has adequate ventilation been provided to prevent the accumulation of flammable vapours above the lower explosive limits of the most hazardous solvent likely to be present? (4.1.1)						
8.4.1.2	Where hot spots or auto-heating may develop in carbon absorption units during standby, are airflows maintained for a period as determined by a risk assessment to dissipate any heat generated? (4.1.2)						
8.4.2	**Ignition protection**						
8.4.2.1	Are all potential ignition sources identified and suitably mitigated by the following: • implementation of suitable hot work controls? • control of static electricity in accordance with BS 5958-1? • identification of hazardous areas in accordance with BS EN 60079-10-1 (ref. 1) and appropriate zoning? and • the identification of other potential ignition sources such as the potential for open flames, hot surfaces and friction? (4.2.1)						
8.4.3	**Containment (spill control)**						
8.4.3.1	Are suitable means for controlling and cleaning up spills provided, together with provisions for the safe disposal of waste? (4.3.1)						
8.4.3.2	When even a small leak is discovered, is intervention and repair instigated immediately? (4.3.2).						
8.4.4	**Exchange**						
8.4.4.1	Is attention always given to eliminating flammable and highly flammable liquids from the workplace wherever possible? (4.4.1)						
8.4.5	**Separation**						
8.4.5.1	Is the siting of the equipment and need for fire-rated separation from surrounding areas influenced by the solvent capacity or flow rate of the unit and subject to risk assessment? (4.5.1)						
8.4.5.2	Are the fire safety provisions for solvent recovery equipment proportionate to the type and solvent capacity of the equipment? (4.5.1)						

		Yes	No	N/A	Action required	Due date	Sign on completion
8.4.5.3	Are distillation units with a capacity of more than 20 litres and carbon absorber processes located outdoors, at least 10m away from buildings and plant, in a detached dedicated building? (Where this is not possible, is the equipment located in a dedicated fire compartment separated from adjacent areas by construction providing at least 60-minutes' fire resistance?) (4.5.2)						
8.4.5.4	If located in a 60-minute fire compartment that is part of a building, does the compartment have at least one outside wall? (4.5.3)						
8.4.5.5	Has the need for any openings into adjacent areas been carefully assessed, and where these are necessary, are they provided with doorsets providing at least one-hour fire resistance? (4.5.3)						
8.4.5.6	Has explosion protection in accordance with the findings of the assessment carried out in compliance with DSEAR been considered for the area in which the recovery plant is located? (4.5.4)						
8.4.5.7	Where small units are in use are the fire safety precautions adopted in accordance with the requirements of RISCAuthority recommendations RC20 Part 1? (4.5.5)						
8.5	**Operation – distillation systems (section 5)**						
8.5.1	Does the design of distillation type equipment include provisions for the monitoring of process conditions at a location that is permanently manned during working hours? (5.1)						
8.5.2	Where steam is supplied under pressure has a pressurised relief valve been installed to operate at 5psi to 10psi above normal operating pressure? (5.2)						
8.5.3	Are pressure relief valves maintained in accordance with the manufacturer's instructions? (5.2.1)						
8.5.4	Are piped vents fitted to the pressure relief valves and condenser vents with the pipes venting outside the building away from potential sources of ignition and so that the vapours will not re-enter the building? (5.2.2)						
8.5.5	Are pipe vents outside the building fitted with flame arrestors? (5.2.3)						
8.5.6	Is the pipework designed to travel as directly as possible to the outside without passing through another fire compartment or be routed through a void area (such as between a ceiling and a floor above)? (5.2.4)						
8.5.7	Are tanks of waste and recovered solvents, together with the still vessel, provided with high and low liquid level monitors that operate automatically to shut down the process safely when adverse conditions occur? (5.3)						
8.5.8	Are the liquid level alarms monitored at an area that is permanently manned when the equipment is in use? (5.3)						

		Yes	No	N/A	Action required	Due date	Sign on completion
8.5.9	Does the still have high temperature sensor(s) that will sound an alarm at the monitoring area and shut off heat supply should the temperature exceed a predetermined safe limit? (5.4)						
8.5.10	Is the cooling water to the still monitored with flow/pressure alarms set at predetermined safe levels? (5.5)						
8.5.11	In the event of the water supply falling below the set criteria, does the heating for the still shut off automatically and an alarm sound at the monitoring area? (5.5)						
8.5.12	Are automatic flammable vapour leak detectors installed to protect large scale processes, or those that operate with minimum supervision? (5.6)						
8.5.13	Do the detectors operate to safely shut the process down at a concentration of about 10% of the minimum explosible limit of the flammable vapour concerned? (5.6)						
8.5.14	Do flammable vapour detection and automatic firefighting systems remain operational during shutdown periods? (5.7)						
8.6	**Operation – carbon absorption systems (section 6)**						
8.6.1	Is the concentration of flammable vapours entering the absorber bed managed to keep it well below the lower flammable or explosive limit of the most volatile solvent likely to be present? (6.1)						
8.6.2	Are suitable precautions taken to prevent auto-heating during extended shutdowns, and do carbon monoxide analysers and automatic water spray provisions remain operational during shutdown periods? (6,2)						
8.6.3	Is consideration given to providing fixed water spray nozzles inside the adsorbers over the carbon bed to wet down the bed in the event of excessive temperature or fire? (6.3)						
8.6.4	Has the vessel in which the absorbant process is undertaken been designed to be able to withstand the additional weight of wetting or fire extinguishing water? (6.4)						
8.6.5	Has the vessel been provided with a drain line designed to operate automatically or by means of a liquid relief valve? (6.5)						
8.6.6	Are appropriate temperature records kept to monitor any increasing likelihood of self heating of the carbon bed over a period of time? (6.6)						

		Yes	No	N/A	Action required	Due date	Sign on completion
8.7	**Fire protection (section 7)**						
8.7.1	Are automatic fixed fire suppression systems installed to BS EN 12845 or other recognised standard, designed to operate automatically as soon as a fire is detected? (7.1)						
8.7.2	Are fixed fire suppression systems designed, installed and commissioned by an engineer with accreditation by an independent UKAS-accredited third party certification body? (7.2)						
8.7.3	Are suppression systems tested and maintained according to the requirements of the relevant British Standard and/or the installer's recommendations by a competent engineer with accreditation by an independent UKAS-accredited third party certification body, with suitable records being kept? (7.3)						
8.7.4	On operation of the fire suppression system, does the process automatically shut down with signalling activated at any remote control point? (7.4)						
8.7.5	Are arrangements in place for the prompt recommissioning of an automatic fire suppression system that has actuated? (7.5)						
8.7.6	Following actuation of the fire suppression system, are procedures in place to ensure that the process is not left working unattended until the measures below have been addressed: • the automatic fire suppression system has been fully recommissioned? and • the equipment has been inspected and found to be serviceable by a competent person? or • appropriate repairs have been undertaken or replacement parts fitted by a competent person to render the equipment serviceable? (7.6)						
8.7.7	In addition to any automatic extinguishing system, are a suitable number of appropriate portable fire extinguishers available and immediately accessible in the case of a fire? (7.7)						
8.7.8	Are portable extinguishers approved and certified by an independent, third party certification body and installed in accordance with BS 5306-8, and inspected and maintained in compliance with BS 5306-3? (7.7)						
8.7.9	Has an automatic fire detection and alarm system complying with BS 5839-1 been installed, designed, installed and maintained by an engineer with accreditation by an independent UKAS-accredited third party certification body? (7.8)						
8.7.10	In zoned hazardous areas, are fire detection systems and communications systems intrinsically safe and appropriate for the temperature and other conditions prevailing in the zone? (7.9)						

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