INSTITUTE OF PETROLEUM

GUIDELINES FOR SOIL, GROUNDWATER AND SURFACE WATER PROTECTION AND VAPOUR EMISSION CONTROL AT PETROL FILLING STATIONS

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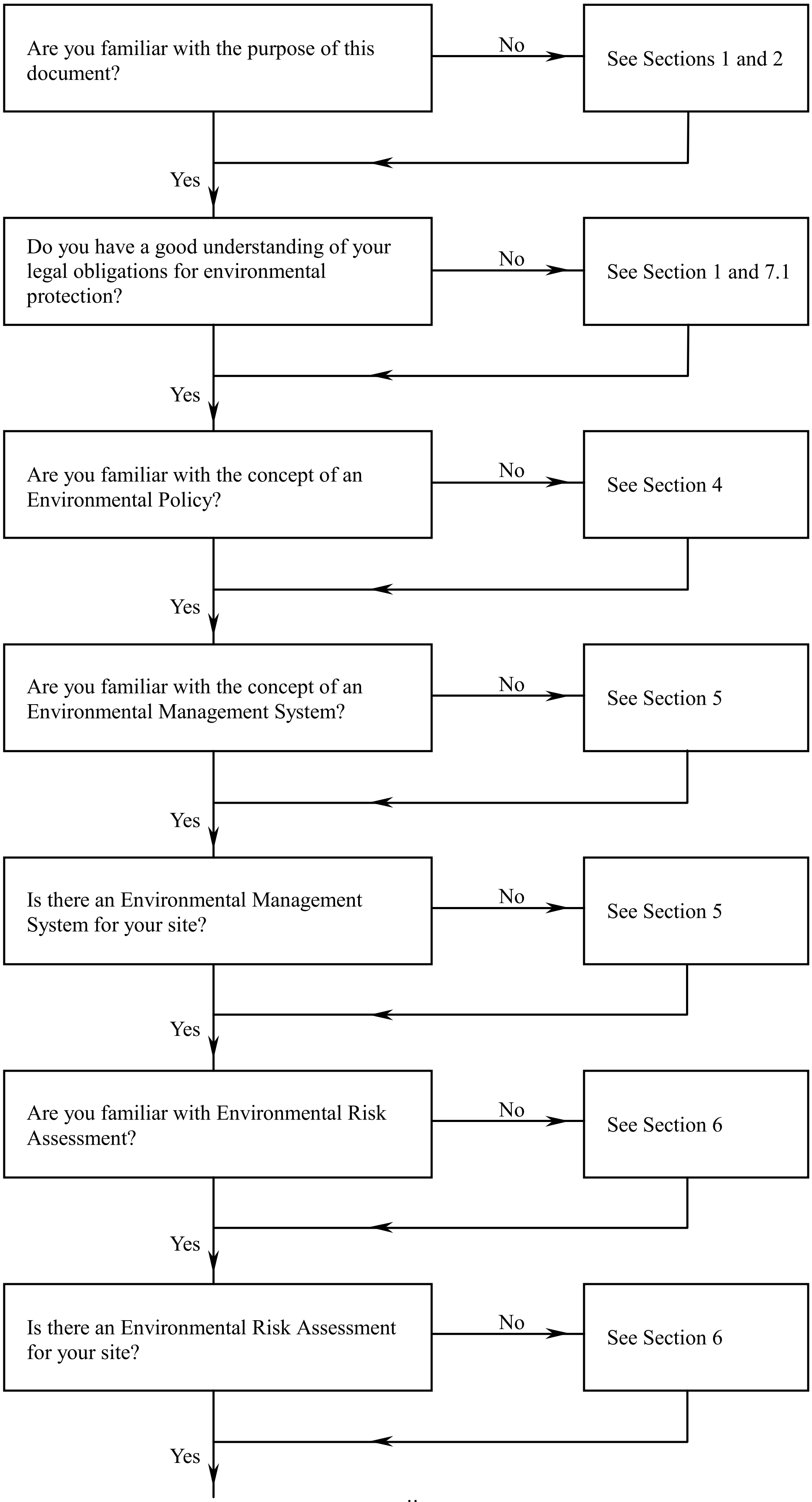

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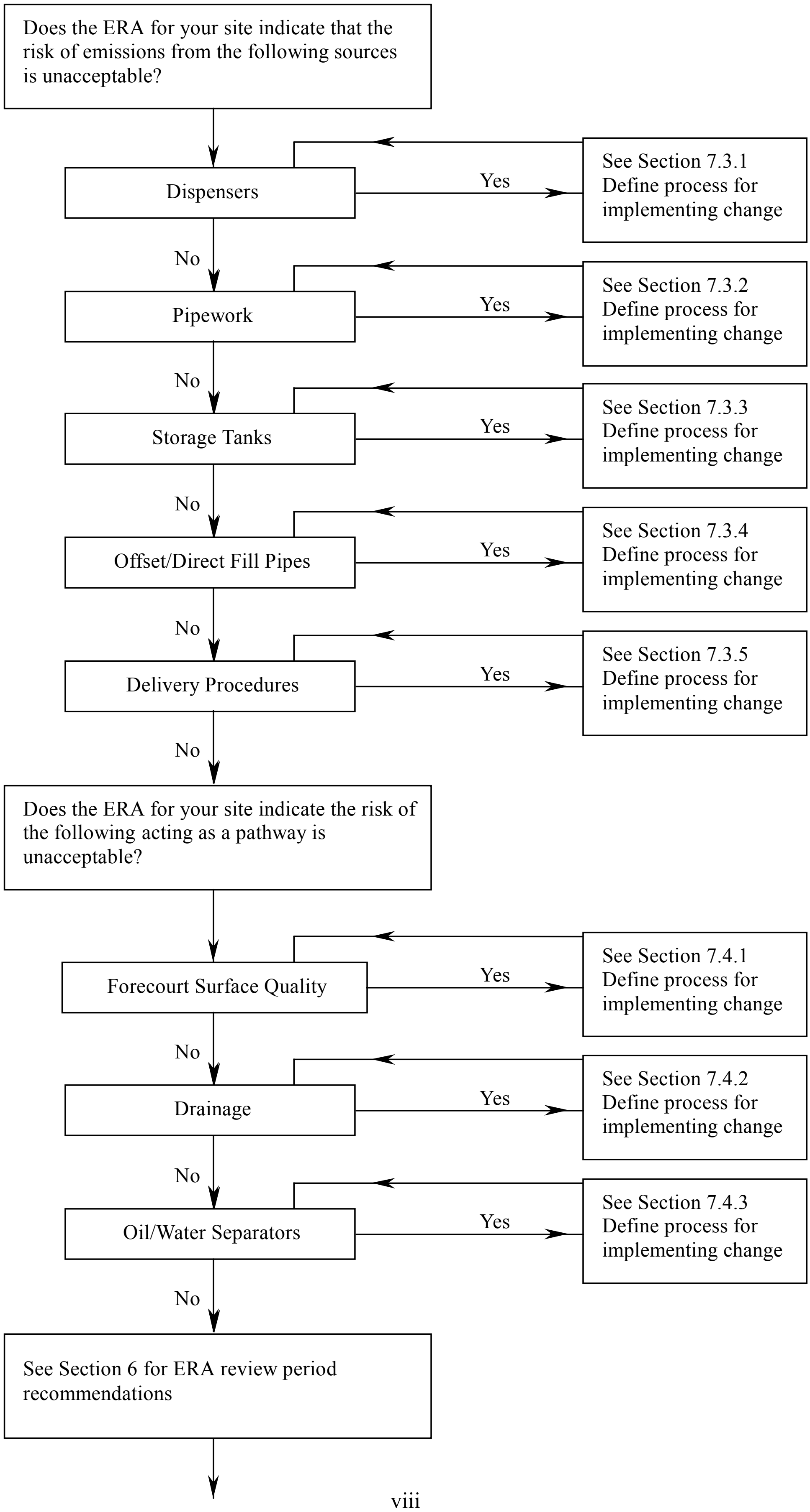

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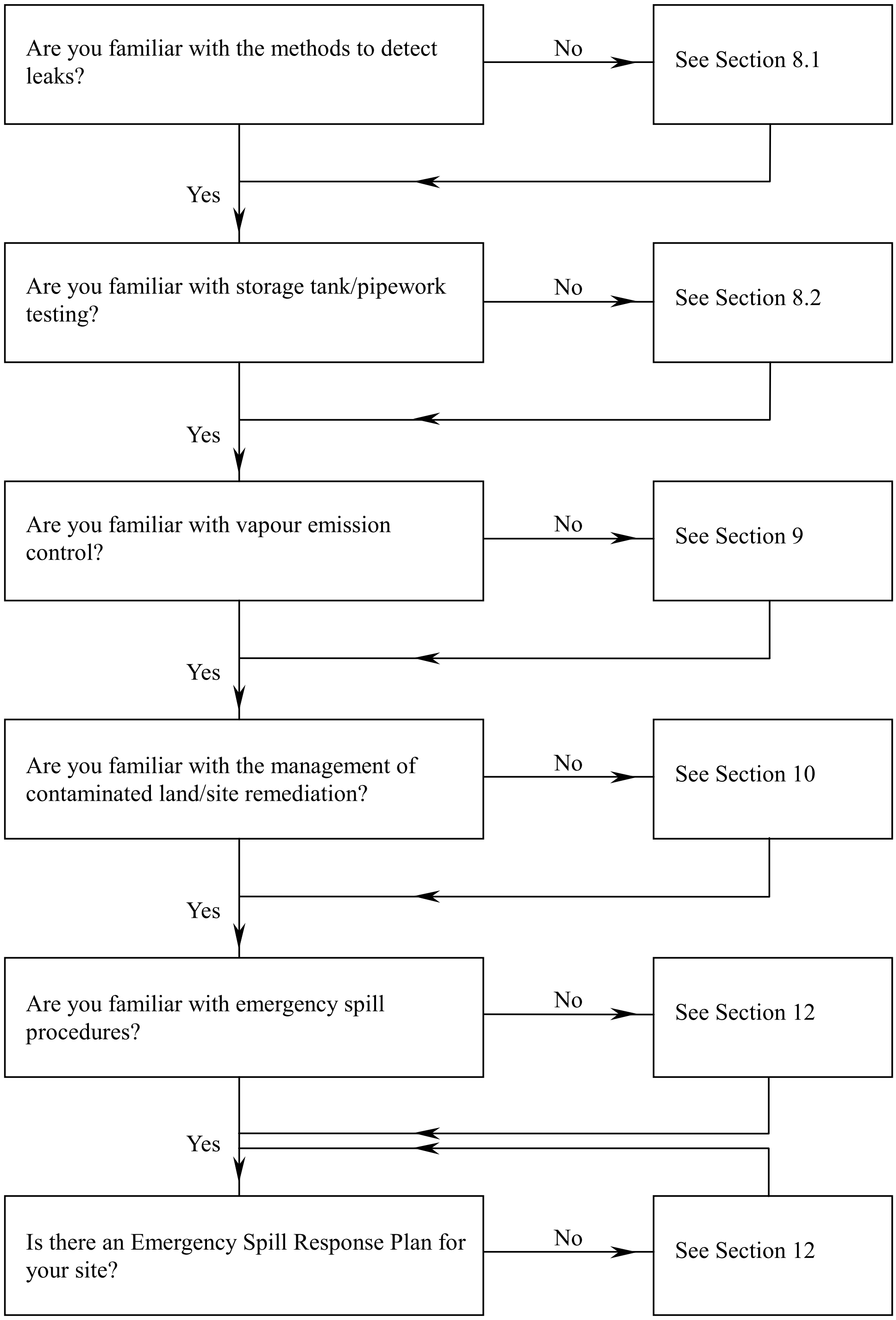

FOREWORD

This publication has been produced by the Institute of Petroleum's Service Station Panel to provide guidance to petrol filling station operators for the protection of soil, groundwater, surface water discharges and air quality at petrol filling stations. The guidance in this publication is intended to complement that contained in the Department for Environment, Food & Rural Affairs' Code of Practice *Groundwater protection at petrol stations and other fuel dispensing facilities involving underground storage tanks* approved by the Minister of State under the Groundwater Regulations, 1998, which applies in England and Wales.

Those wishing to follow any of the engineering options detailed in this publication should satisfy themselves that due consideration is given to the potential impact on safety that any changes may have. For guidance on safety issues readers are referred to IP/APEA *Guidance for the design, construction, modification and maintenance of petrol filling stations*.

Although it is hoped and anticipated that this publication will assist those involved in the operation of petrol filling stations, the Institute of Petroleum cannot accept any responsibility, of whatever kind, for damage or loss, or alleged damage or loss, arising or otherwise occurring as a result of the application of the guidance contained herein.

Suggested revisions are invited and should be submitted to the Technical Department, Institute of Petroleum, 61 New Cavendish Street, London W1G 7AR, UK.

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Association of UK Oil Independents (AUKOI)
Association of Forecourt Systems Contractors (AFSC)
Berry & Co
BP
ChevronTexaco Ltd.
Conoco Ltd.
Environment Agency
Esso Petroleum Company Ltd.
Health and Safety Executive
Kuwait Petroleum (GB) Ltd.
Petrol Retailers Association (PRA)
Petroleum Equipment Installers and Maintenance Federation (PEIMF)
Petroleum Enforcement Liaison Group (PELG)
Shell UK Ltd.
Tesco Stores plc
TotalFinaElf UK Ltd.
United Kingdom Petroleum Industry Association (UKPIA)
Veeder-Root

The Association for Petroleum and Explosives Administration (APEA) is thanked for agreeing to the reproduction of several sections of text taken directly from APEA/IP *Guidance for the design, construction, modification and maintenance of petrol filling stations*.

1

INTRODUCTION

The need for good environmental performance has always been a requirement, but increased public awareness and new regulations over the last few years have brought it into sharp focus. Many companies already have good practices and procedures to protect groundwater, soil, surface waters and prevent vapour emissions to air, but up to now there has not been agreed petroleum industry guidance for service stations.

This publication is intended to be a reference guide for any individual charged with environmental protection of petrol filling stations. It outlines the minimum standards expected of a well operated facility whose owner/operator seeks to meet the requirements of the European Directive 80/68/EEC and UK Groundwater Regulations 1998, provides details of best practice and is intended to act as a bibliography and guide to other more detailed legislation, codes of practice and relevant publications.

These guidelines concentrate on the practical means of minimising the potential impact of motor fuels where they are stored and dispensed to the public at petrol filling stations to soil, groundwater, surface waters and local air quality. It is recommended that these guidelines should form part of the Environmental Policy of the company that owns the installation. Such a policy will set the broad long-term objectives without giving details of how they are to be achieved. An Environmental Management System then provides a structured means of deciding what has to be done to satisfy policy requirements and should be an integral part of the normal management process. It will include organising implementation, checking results against targets and making adjustments as necessary to ensure the original objectives are met. If the policy calls for continuous improvement then the process of planning, action and review needs to be ongoing.

A number of recognised management systems are available, e.g. ISO 14000, ISO 9000 and Eco Management and Audit (EMAS). However it is neither a legal requirement nor a recommendation of the Institute of Petroleum to have the management system externally verified and accredited. The duties and responsibilities described in the following guidelines may be carried out by site personnel, or other people within the organisation. Records may also be kept locally in whatever form is easily accessible and maintainable.

Within the UK, health and safety issues associated with the design, construction, modification, maintenance and operation of petrol filling stations are subjected to a regulatory regime, guidance for which is contained elsewhere. In addition, other authorisations may be required from one of the Environment Agencies[1], a water company, and the Local Authority Environmental Health Department, whose aim is to ensure adequate environmental protection.

[1] Depending on location in the UK authorisations may be required from either the Environment Agency (in England and Wales), the Scottish Environment Protection Agency or the Environment and Heritage Service (in Northern Ireland). These are referred to as the 'UK Environment Agencies' throughout this publication.

In countries outside of the UK, sites also operate under a variety of authorisations, licences and consents that stipulate minimum operating standards. These conditions may be enforced at Local, State or Federal/National level. It is anticipated that these guidelines may prove to be a useful reference for those responsible for ensuring adequate environmental protection measures are in place.

In reading the guidelines it should be noted that actions to minimise release of hydrocarbons to the environment may also lead to improvements in safety performance, healthier working conditions for employees and more cost-effective operations.

The guidance offered is intended for international use but, where appropriate, reference is made to EC and UK legislation. In other countries reference should be made to national legislation and recognised operating practices.

A number of guidelines and codes of practice provide details of specialist aspects of the environmental impact of fuel storage and dispensing. The following subjects are covered briefly in this publication, with more detail to be found in the publications listed in the bibliography:

- vapour recovery;
- general construction issues;
- groundwater risk assessment of existing operations;
- fire and explosion risk assessment (see HS(G) 146);
- CNG or LPG;
- local ambient air quality impacts of station operation.

2

SCOPE

This publication aims to provide:

- An explanation of the soil, groundwater, surface water and air quality issues involved in the operational aspects of petrol filling stations.
- A reference document for minimum standards of operation and guidance on cost-effective practices to minimise impact to soil, groundwater, surface water and air.
- Details of 'best practices' to enhance protection of soil, groundwater, surface water and air.

3

PHILOSOPHY

The philosophy presented in these guidelines is that "prevention is better than cure" and that there should not be a reliance, solely, on the so-called "end of pipe" solution to clean up emissions[2] arising out of operations. Therefore the overall aim should be fuel containment integrity, from the tanker off-loading point to the dispenser nozzle, through correct operational procedure, site design, construction and maintenance. If an emission stream is not generated, it does not have to be cleaned up or controlled.

To implement this simple philosophy it is necessary to raise the level of understanding of all personnel on how to operate existing equipment and facilities to ensure, as a minimum, that environmental performance meets legal requirements.

It is therefore necessary to understand and analyse the operations to identify all the potential sources of emission and then tackle the largest potential sources first. The cost effectiveness of this approach is illustrated by Figure 1.

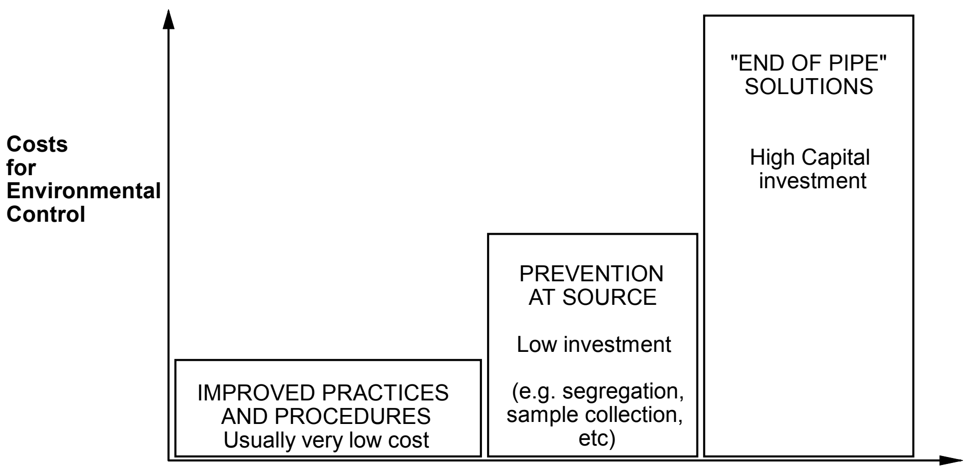

Figure 1 - Cost effectiveness

[2] Emission is defined as a 'release of product to the environment' and is not therefore limited to petroleum vapour.

It should be recognised that the requirement for enhanced environmental protection is likely to increase and it will be important to demonstrate that the knowledge, training and the management capability and commitment to handle the problems exist.

4

ENVIRONMENTAL POLICY

An environmental policy should be developed which outlines the way a company or site operator is to exercise control over potentially polluting operations. The environmental policy can be an extension of an existing safety policy or a separate document. It should make commitments to the following:

— Compliance with all local environmental laws, regulations and site specific conditions of authorisation, as a minimum, together with the setting of self-imposed responsible standards where laws and regulations do not exist, or the operator wishes to achieve higher standards.
— Conducting business in a manner which balances environmental and economic needs of the community.
— Continuous assessment and review to improve environmental performance.
— Communication with the public on environmental matters and sharing information and experience with others to bring about improvements in performance.

See Annex B for a model safety, health and environmental policy.

These are broad directional commitments which recognise that a company will have to operate within a changing climate as the expectations of the public, their representatives and regulatory authorities, grow more demanding. At the operational level, an effective management system is essential to ensure performance continues to improve, to match the increasing demands required by the policy.

5

ENVIRONMENTAL MANAGEMENT SYSTEMS

5.1 GENERAL

An Environmental Management System (EMS) should be developed, which considers organisational structures, responsibilities, operational measures and resources required to implement a company's environmental policy and to monitor and control performance. It should be flexible enough to take account of site specific conditions and specific Industry initiatives and should ensure that environmental considerations are continuously integrated into business decisions in a systematic way.

Initially, the EMS may concentrate on providing information and raising the level of environmental awareness; subsequently, the emphasis will switch to specific operational targets for improvement measures. See Figure 2.

5.2 LICENCES AND CONSENTS

A site may have a number of consents, covering emissions to the environment, issued by appropriate regulatory authorities. These may specify equipment and operating standards as well as the maximum allowable levels of emissions. Copies of all consents, licences and records should be accessible to site staff and it is recommended that they be stored on site.

5.3 PLANNING

The systematic achievement of environmental policy objectives requires an assessment of the risk of detrimental impact to soil, groundwater, surface water and air quality. The principles of risk assessment are covered in Section 6. The plan should be reviewed regularly, usually annually, as follows:

— Assess the environmental performance of current operations against statutory consents and company standards.
— Identify improvements needed.
— Review regulatory and legislative developments with assistance of Trade Associations.
— Review complaints.
— Modify the environmental objectives to take account of these developments.
— Establish a dialogue with the regulatory authorities, local authority and public.

Short-term plans within the framework of a long-term strategy will enable staff to monitor progress, and to ensure achievement of goals. Where major changes are planned it is particularly important to carry out an assessment of their possible effects on soil, groundwater, surface water and air quality. This can be done using the risk assessment technique described in

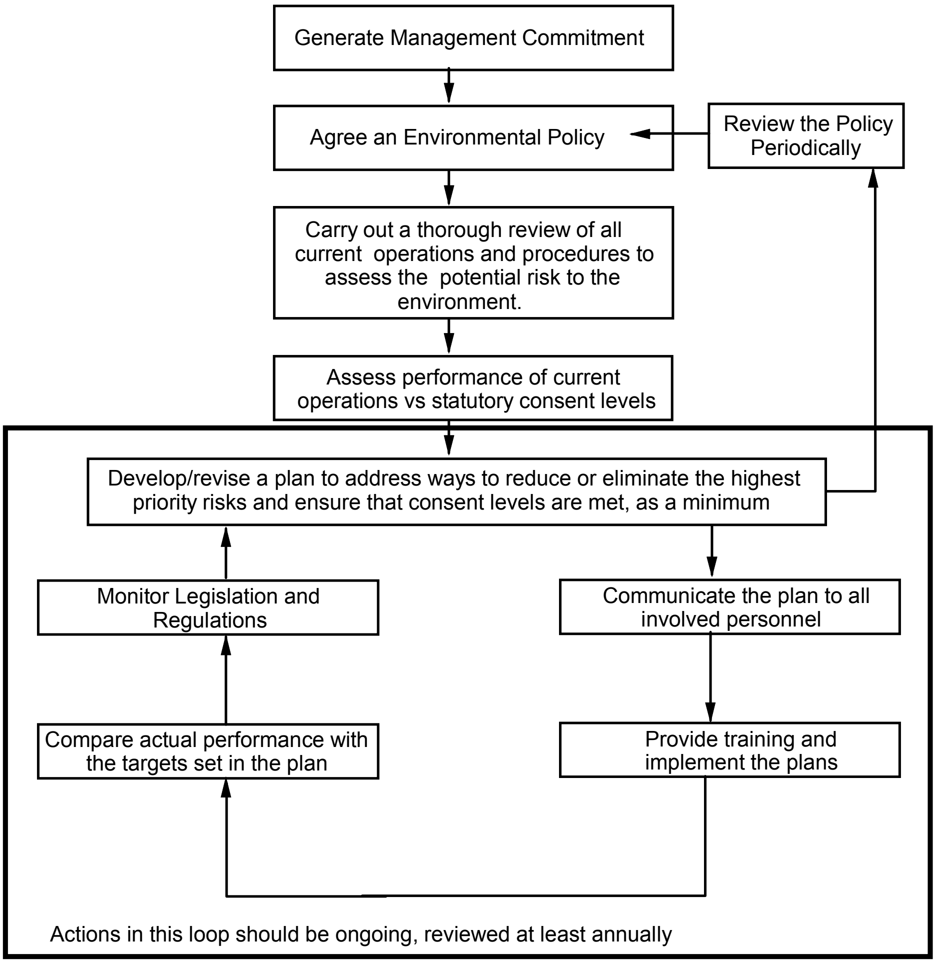

Figure 2 – Environmental management structure

Section 6. Such an assessment should also include simple cost/benefit analysis to help in planning and prioritising changes.

5.4 ORGANISATION AND COMMUNICATION

Management should be responsible for environmental protection and performance, for which staff at all levels are accountable. Improvements can only be made with the full support of all employees. It is recommended that the responsibility for development of policy, drawing up of programmes and regular reviewing of progress should be given to one person.

To earn support it is essential to raise environmental awareness amongst personnel, both full time and contract, so that they have a clear understanding of what the company is trying to achieve and why. All personnel should be made aware of how to contribute to a two way process of reducing the potential impact of site operation on soil, groundwater, surface water and air quality. It may be necessary to provide training for employees where existing standards are changed, or new ones established, in order to take account of environmental requirements.

External communication is necessary if good working relationships are to be established with regulatory authorities and neighbours. Any environmental complaints should be recorded along with the action taken and by whom. Responses should be professional, courteous and tactful. Local relationships can prove to be an invaluable asset in the event of an environmental incident. It is helpful to maintain a good record of all environmental improvements and changes made.

In order to meet environmental performance targets the Responsible Person in charge of the station should ensure that:

- all staff and customers comply with site rules and procedures;
- all maintenance visits are recorded;
- equipment is inspected (see below) and all tests and maintenance are carried out when required;
- adequate information, instruction and training to staff is provided;
- Material Safety Data Sheets are provided;
- any environmental measures that may be needed are immediately actioned and a record of them kept;
- any accidents, incidents are recorded;
- a suitably trained stand-in is available in the event of absence.

Similarly all employees should ensure that:

- All unplanned or non-approved discharges to the environment are fully recorded and management advised.
- All appropriate procedures for controlling emissions to the environment are fully observed.
- All faults on equipment and fittings are entered in the site log to enable remedial action.
- All complaints from members of the public are recorded to enable follow-up action.

5.5 IMPLEMENTATION

Performance targets, consistent with short and long-term policy objectives, should be developed. These must take account of existing regulatory consents and set a minimum standard to be maintained at all times. As targets are developed they should anticipate changes, financial constraints and technical and operational developments.

In addition to statutory inspection and test regimes on vapour recovery equipment, the introduction of voluntary inspection programmes should be considered. All inspections and tests should be scheduled on a regular basis.

See Annex A for a model schedule of daily, weekly, monthly and annual inspections and tests.

A log book for recording and reporting of failures should be introduced in order to extend understanding of environmental impact and to avoid further failures.

Incident investigation and corrective action should be made and recorded.

5.6 CONTROL AND VERIFICATION

Control and verification of the measures implemented can be achieved through monitoring and audits. Improvement in performance depends very much upon raising environmental awareness of employees. Regular assessments involving both the Responsible Person/management and operators to identify improvements made, and areas for further improvement, are strong stimuli.

Complaints and any incident affecting soil, groundwater, surface water or air quality should be reviewed by the site manager.

Reporting and reviewing environmental performance should be a regular process, with the frequency aligned to the risk associated with the environmental impact. Where performance is falling short of expectations, action can then be taken in time to ensure the short term targets are met. Environmental auditing should be a systematic, objective and fully documented exercise to demonstrate the way in which management and facilities are performing in safeguarding the environment.

The results of this review should be communicated to the operational personnel providing the information. In the UK, regulations require most inspections to be documented, and this should be done using a register, logbook or other record that satisfies the minimum requirements.

5.7 REVISION OF PLANS

The periodic review and audit of inspection records and other documentation should include a review of targets and goals. This process forms part of the environmental risk assessment (ERA) and continual improvement.

6

ENVIRONMENTAL RISK ASSESSMENT

The first step in understanding the implications for soil, groundwater, surface water and air quality of operating a petrol filling station is to undertake an environmental risk assessment (ERA).

The purpose of undertaking an ERA is to identify parts of an operation that could cause emission of hydrocarbons (in either liquid form or as vapour), and assess the likelihood and consequences of the release. The ERA can also be used to contribute to the planning and design process as it should indicate the need or otherwise for improved engineering controls. However it should be noted that the conclusions of an ERA may preclude site development in the most 'environmentally sensitive' areas.

An ERA consists of five stages:

1. Identify potential sources of pollution.
2. Identify what may go wrong to cause a release in each area and assess the consequences.
3. Identify what is in place to prevent such a release.
4. Identify what measures are in place to minimise the effects of any release that may occur.
5. Decide if these measures are enough, or if improvements are required to reduce risk.

In order for pollution to occur, three components must be present, which are collectively termed a 'pollutant linkage' under the definition given in Part IIA of the Environmental Protection Act 1990:

(a) There must be a source of pollution.
(b) There must be a pathway to a receptor.
(c) There must be an environmental receptor that can be affected.

Examples of pollutant linkages are given in Table 1, see also Figure 3.

Table 1 – Pollutant linkages

Source	Pathway	Receptor
Leaking underground fuel tank	Permeable strata above water table	Groundwater in aquifer
Poorly maintained oil/water separator	Surface water sewer	Surface watercourse
Faulty pressure/vacuum vent on tank vapour manifold	Prevailing wind direction	Air quality in local residential area

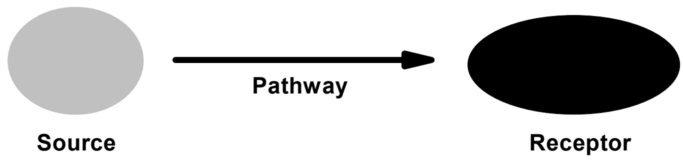

Figure 3 – Pollutant linkage

If any of the three components in this example is absent, then there is no pollutant linkage and the site may not pose a risk to the environment. It is important to remember, however, that new sources, pathways and receptors may arise at any time in the future, and these will need to be considered to ensure that the risk assessment remains valid. Breaking the linkage, by removing any one or more elements, removes the risk associated with that linkage.

The process of ERA is similar to the fire and explosion risk assessment as recommended in HS(G) 146. For more detailed information on the methods of performing an ERA see IP publication *Guidance document on risk assessment for the water environment at operational fuel storage and dispensing facilities*, developed in conjunction with the Environment Agency.

By reviewing the type and condition of equipment on site and putting it in a site specific context (both in terms of surrounding neighbours and environment), it is possible to judge relative risks of pollution.

An ERA requires the identification of source risks, pathways and receptors/consequences from *inter alia*:

— tank and pipe age, soil chemistry conditions, oil/water separator design, leak and spill history. All potential sources;
— drainage layout, geology and underground services. All potential pathways;
— proximity of houses, cellars, rivers, aquifers, water abstractions. Potential receptors.

An ERA should be carried out at all sites, regardless of age. It should be reviewed periodically, and always prior to significant changes to site infrastructure, or surrounding land use caused by external influences. Where a site is determined by assessment to be 'high risk', the suitability of emission control measures should be reviewed immediately, see section 7.

In extreme circumstances e.g. a poorly run station adjacent to a drinking water abstraction well, the Environment Agency may consider the risk unacceptable and either serve an improvement or prohibition notice. The Environment Agency may also object to planning applications for redevelopment of a site through the planning regime.

In the UK, regulatory bodies often use ERA as a way of setting inspection priorities, see 7.1. It may be possible to obtain copies of regulatory ERA or complete the exercise jointly, as both owner and regulator have access to site specific information.

For a model questionnaire to facilitate the undertaking of ERA, see IP *Guidance document on risk assessment for the water environment at operational fuel storage and dispensing facilities*.

7

EMISSIONS TO SOIL, GROUNDWATER AND SURFACE WATER

7.1 GENERAL

Hydrocarbons which escape from containment at a petrol filling station may enter the soil directly beneath the site, or around its perimeter. Motor fuel entering the soil will, because of its known toxicity, have a detrimental or fatal effect on the flora and fauna within the contaminated area. Its subsequent dispersion will depend on migration of fuel, water movement, biodegradation and soil absorption. The extent and duration of the pollution will also depend on the quantity and duration of the motor fuel release and any subsequent action.

Soil, and the substrate beneath it, may contain water that ultimately feeds a water supply for people or animals, or supports river flows, wetlands or other aquatic habitats, see Figure 4. Groundwater in the vicinity of the petrol filling station may or may not be fed from water falling on the surface at the filling station, depending on whether there is a path for it to follow. Components of motor fuels have significant solubility in water and once dissolved can give rise to contaminant plumes that can pollute significant volumes of water. As well as being toxic towards aquatic life, motor fuels may cause health problems to humans if ingested and because of this, any contamination will have to be removed from potable water by the relevant water supply companies.

In Europe, EC Directive 80/68/EEC specifies that there should be no entry of List 1 substances, including mineral oils and hydrocarbons, e.g. benzene (see Table 2), into groundwater.

Table 2 – List 1 Substance from EC Directive 80/68/EEC

Organohologen compounds (and substances which may form such compounds in the aquatic environment)
Organophosphorous compounds: any organic compound which contains one or more covalently bonded phosphorous atoms
Organotin compounds: any organic compound which contains one or more covalently bonded tin atoms
Mercury and its compounds
Cadmium and its compounds
Cyanides
Substances which are carcinogenic eg benzene, mutagenic or teratogenic in or via the aquatic environment
Mineral oils or hydrocarbons

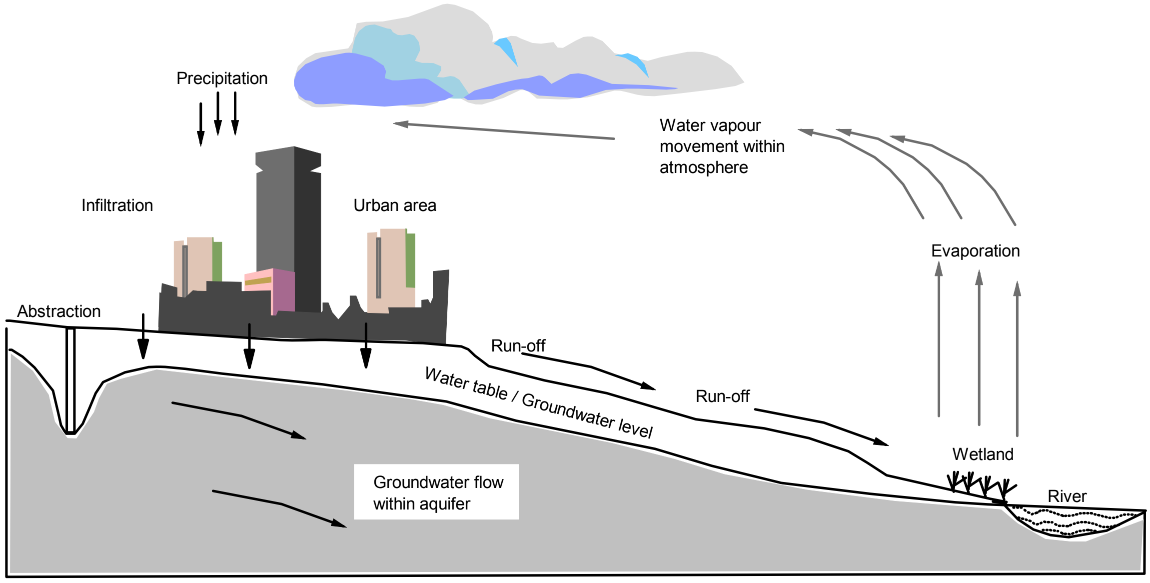

Figure 4 – Schematic of the water cycle

In England and Wales the discharge of motor fuel to watercourses is controlled principally under the Water Resources Act 1991 which states that it is an offence to discharge poisonous, noxious or polluting material (which includes petrol) into any 'controlled waters' (which includes any watercourse or underground strata) either deliberately or **accidentally**. In England and Wales guidance has been issued by the Department for Environment, Food and Rural Affairs in Code of Practice *Groundwater protection at petrol stations and other fuel dispensing facilities involving underground storage tanks*. In the UK the Environment Agencies are responsible for the protection of controlled waters from pollution and several relevant guidance notes have been issued, for example PPG3 *Use and design of oil separators in surface water drainage systems.*

In England and Wales the EA has developed Source Protection Zones to support their groundwater protection policy. The Agency's policy approach affords the greatest protection to groundwater resources most at risk and enables pollution prevention measures to be targeted more effectively. Source Protection Zones provide an indication of the risk to public water supplies resulting from potentially polluting activities and accidental releases of pollutants. Generally the closer the activity or release is to a groundwater source the greater the risk. The Zone classification used is shown in Table 3. For further information see the following pages of the Environment Agency website:

http://www.environment-agency.gov.uk/subjects/waterres/groundwater
http://www2.environment-agency.tv/gwcl/gwvmpicker_1.htm.

For Scotland, groundwater vulnerability maps may be obtained from British Geological Survey[3] and advice should be sought from SEPA.

When undertaking a site ERA it is important to have a clear understanding of the sensitivity of groundwater to hydrocarbon emissions. Whilst the Groundwater Directive requires all groundwater to be protected, not just that in Source Protection Zones, the Zone classification should form an essential part of any ERA and prioritisation process.

Table 3 - Environment Agency For England and Wales Groundwater Source Protection Zones

Zone	Criteria
Inner Zone I	50 day travel time from any point below the water table to the source. Minimum size 50 m.
Outer Zone II	400 day travel time or 25% of the catchment area, whichever is the larger.
Source catchment Zone III	Area needed to support the protected yield from long term groundwater recharge.

[3] British Geological Survey can be contacted via their website www.bgs.ac.uk

7.2 POTENTIAL SOURCES OF EMISSIONS DURING NORMAL SITE OPERATIONS

The ERA needs to take account of the fact that despite rigorous operating procedures and mechanical integrity of equipment some product may escape from containment to groundwater during normal site operations. Effective control and limitation of these releases is a second line of defence after containment.

The principal sources of loss of product containment, in approximate descending order of frequency of incidents (not volume of product), are shown in Table 4. For further details of the sources see 7.3.

Table 4 – Sources of discharges

Possible discharges in runoff to surface watercourses.	
Leaks from:	— under dispenser valves and flexible couplings — pipework — tanks and offset fill pipes — faulty oil/water separator operation
Possible discharges to soakaways.	
Spills during:	— customer refuelling, including leaking car fuel tanks — filling of petrol filling station underground storage tanks directly or by below ground level offset fill points — filling of petrol filling station underground storage tanks via above ground level offset fill points — overfilling of portable containers

7.3 SOURCES OF DISCHARGES - SITE INFRASTRUCTURE AND EQUIPMENT OPTIONS

Where an ERA identifies unacceptable risks (either as a result of environmental sensitivity or current infrastructure/equipment performance), or opportunities for improvement and cost reduction, the operator should review the site infrastructure and equipment options detailed in 7.3.1 – 7.4.3

7.3.1 Dispensers and under dispenser trays

Experience has shown that dispenser (pump) leaks are the most common form of containment failure at petrol filling stations and may range from air separators, dispenser valves or flexible couplings. As dispensers can be set over open soil, any leak may go straight to ground. It is therefore recommended that **all dispensers** should be fitted with a leak proof drip tray or membrane arrangement beneath the dispenser (as required by BS 7117 Part 2: 1991 for new dispensers) to ensure that product from small internal leaks flows onto the forecourt surface where it will be noticed, and diverted to the site drainage system. Drip trays can also be fitted with monitoring devices. With pressure systems, leak proof sumps may be used instead of, or in addition to, a drip tray. These provide convenient access below the dispenser to any isolating and impact check valves and for the connection of pipework. Under pump sumps are likely to contain vapour. To avoid ground contamination, and the likelihood of a potential explosion hazard, special precautions will be necessary. Consequently under pump sumps should be:

— impervious to the fuel;
— adequately protected against corrosion;
— sealed at all pipe entries to prevent fuel leakage into the ground and ingress of groundwater;
— fitted with an appropriate leak detector device certified for use in a Zone I hazardous area;
— designed to allow easy removal of any fuel or water that may accumulate.

All installations should be inspected for integrity periodically and as a minimum every six months.

Dependent on the outcome of the ERA an option that may be considered is the replacement of problematic dispensers with new ones which meet the requirements of current design standards.

7.3.2 Pipework

Experience has shown that leaks in underground pipework outnumber leaks from storage tanks 10:1 and in terms of leak size **are the principal source of soil and groundwater contamination** beneath petrol stations. This has in a large measure been a direct consequence of the vulnerability of buried steel pipework to corrosion which, coupled with inadequate attention to corrosion protection during installation, particularly of the vulnerable cut threads of screwed joints, has lead to serious point corrosion and early failure of pipework. Steel pipework was usually installed, but since 1989 has usually not been approved for new installations without effective anti-corrosion protection.

The development of non-metallic pipework and latterly the better protection available for steel pipework, together with the technique of secondary containment, has been a direct result of increased awareness of the consequences of unabated pollution.

A test of existing pipework may be required if a leak is suspected, (see also Section 8). The methods used will be determined by the type of pipework, its installation and an assessment of the risks involved in using each method. For details of suitable test methods see 8.2, APEA/IP *Guidance for the design, construction, modification and maintenance of petrol filling stations* and HELA PETEL circular 65/34 *Leak detection in tanks and pipework*, October 2000.

If pipework is subject to corrosive failure, it should be replaced, see Section 12. In such circumstances consideration should be given to fitting an under dispenser check valve and removing the angled check valve on the tank lid to provide immediate drain back.

The removal of any pipework should not commence until a risk assessment has been carried out and the pipe has been drained and isolated from sources of fuel. A flammable atmosphere or residue of motor fuel may be present in the pipework and a precautionary measure of flushing with water should precede the removal and dismantling work. Due to the risk of petroleum vapours being present when pipelines are disconnected, continual atmosphere monitoring is recommended. Excavated pipeline should be removed from site as soon as possible and disposed of safely. Water used to flush out the pipework should be collected for safe disposal. It may be possible, subject to approval, to discharge this water through the on-site oil/water separator.

For guidance on the design considerations for the selection of new pipework see Chapter 8 of APEA/IP *Guidance for the design, construction, modification and maintenance of petrol filling stations*. Key points to note are:

— It is essential that steel pipework has adequate protection against corrosion, particularly of the joints, or is secondarily contained and provided with a system which continuously monitors the interstitial space for the integrity of both skins.
— Joints for steel pipework may be mechanical or welded. In either case special precautions will be necessary to ensure that the integrity of the corrosion protection is fully maintained and can be sustained for the lifetime of the installation.
— Steel and GRP pipework should always be connected to tanks or dispensers using flexible connections to allow for relative movement and ensure no resulting load is transmitted to the pipework.

It is recommended that operators should ensure that new non-metallic pipework meets the requirements of IP *Performance specification for underground pipework systems at petrol filling stations*, 2nd edition. That document provides performance testing procedures to demonstrate that a product has overall fitness-for-purpose for use in underground piping systems, and encompasses all issues relating to operational life expectancies of at least 30 years. The document also includes a requirement for new samples of a manufacturer's product to be tested annually, to ensure that it continues to meet fully all performance requirements.

Depending on the outcome of the ERA for the site, consideration should be given to the need to install pipework with either Type 1 or Type 2 secondary containment. The main function of secondary containment is to retain any leaks from fuel carrying pipes and to provide a conduit for leak detection. For further details see IP *Performance specification for underground pipework systems at petrol filling stations*.

Experience has shown that a high proportion of pipework leaks result from poor installation. The IP specification places a requirement on pipework manufacturers to make available a written manual on the correct methods of laying out underground systems, and details of how to make sound pipe connections and any proprietary techniques and tools to achieve reproducible leak-proof joints. The manufacturer's manual is also required to provide a checklist of sequential actions necessary to achieve a correct installation, and instructions for safety and repair.

It is recommended that every person undertaking an on-site installation shall have received training on best practice for the specific commercial pipe system being installed. It is the responsibility of pipe manufacturers, or their designated distributors, to provide training to installers either on-site or through specific courses with representative installation layouts. Site operators should determine that installers have undergone a refresher course within the previous five years.

7.3.3 Storage tanks

The following provides a summary of current and historic tank types and configurations to assist in the ERA. For further details on tankage design considerations, see Chapter 7 of APEA/IP *Guidance for the design, construction, modification and maintenance of petrol filling stations* and EA PPG27 *Installation, decommissioning and removal of underground storage tanks*.

7.3.3.1 Types of tank

Several types of storage tank are available for use both above and below ground. Tanks are generally cylindrical and installed horizontally. Tanks are commonly manufactured from steel, glass reinforced plastic (GRP) or using a combination of steel and plastic or GRP. They may be single skin or double skin depending on the type and construction and the intended use. The risks arising from a loss of integrity will vary with the circumstances at each site and the selection of the appropriate type of tank should be determined from an ERA. LPG systems are pressure systems and in the UK need to conform with the requirements of the Pressure Systems Safety Regulations 2000:

- Prior to *ca*. 1960 underground storage tanks were generally located beneath dispensers and often placed adjacent to the front site boundary. Typically 500 gallon capacity.
- Prior to 1990 underground storage tanks were generally constructed of single skin steel.
- Older tanks may be set in a brick/concrete vault, set in mass concrete, sand, or earth backfill.
- Since 1990 new underground storage tanks are increasingly double skin steel, with interstitial monitoring and set in pea shingle or foam.
- Since around the mid-1980s single skin steel tanks may have been lined with new single or double liners, often with interstitial monitoring.
- LPG storage vessels, as pressure vessels constructed to BSI Published Document 5500, can either be installed above ground or covered with gravel, sand or foam backfill. The vessel can either be buried (completely underground) or mounded (partially underground).

7.3.3.2 Replacement with a new tank

If a breach in tank integrity is identified, several options could be followed. A breach of underground storage tank integrity on the lid or high in the ullage space may not necessarily result in a leak. However, the lower down the body of the tank the greater the potential for loss of product. It should also be recognised that tank leaks may also be a cause of water ingress, where the groundwater table is above the hole. Any corroded or defective tank which has been identified underground should be taken out of use, see also Sections 12 and 10. If the reduced tankage is insufficient for the site, and a replacement is required, consideration may be given to installing new double skin tanks by carrying out an ERA, especially where the site is located on a major or minor aquifer, or on a non-aquifer used locally for potable supply. The tank should be constructed of a material that is resistant to the local ground conditions, or provided with appropriate corrosion protection. New metal tanks are generally protected against corrosion by the application of an external protective coating. Such coatings are specified for tanks complying with BS EN 12285. Coatings should be inspected for damage and may be tested for thickness and continuity prior to installing the tank. Any damage should be made good in accordance with the manufacturer's instructions.

7.3.3.3. Corrosion protection

Corrosion control for either new or existing tanks can be provided by cathodic protection in which sacrificial anodes are used. The anodes are normally magnesium or zinc and details of the necessary type and size should be sought from the tank manufacturer. Tanks protected in this way should be electrically isolated from pipework and conduit through use of isolation bushings and flanges. It must be recognised, however, that metalwork on either side of such isolation bushings may be at different electrical potentials and such actions should be discussed and agreed with the electrical designer to ensure that an unsafe condition cannot arise. A method of testing to confirm the continued effectiveness of the system should be provided.

For existing tanks corrosion control can be provided using an impressed current system. Electrical currents from such systems can influence other nearby metallic structures which are not part of the protected system. Proper design by a competent corrosion engineer is required to prevent adverse effects on adjacent above ground tanks, utilities and other metallic structures. This should be carried out by a competent corrosion engineer working in close liaison with the electrical designer and the manufacturers of any equipment installed within or on the tanks, e.g. leak detection or tank gauging systems.

The most effective corrosion protection is provided when high quality coatings and an appropriate cathodic protection system are used in combination.

- One risk reduction method is to install cathodic protection to existing tanks, which have not corroded significantly. Virtually all the corrosion of buried steel occurs by an electrochemical mechanism. To assess the risk of external corrosion failure requires measurement of soil conditions such as moisture, conductivity, pH, sulphides, chlorides, electrical activity etc.

Further guidance on the use of cathodic protection for underground storage tanks and associated steel pipework will be provided in a forthcoming IP publication.

7.3.3.4 Tank repair

Dependent on the outcome of the ERA, consideration may be given to obtaining a detailed inspection and assessment by a competent person to determine whether repair of a tank, rather than replacement, may be feasible. For existing single skin tanks the repair is normally carried out using a specialist lining technique and may provide a double or a single skin within the existing tank shell. It is recommended that such relining is only undertaken by suitably trained and competent personnel. Site operators should satisfy themselves that the relining activity conforms to basic requirements for tank preparation. For double skin tanks it will be necessary to determine whether the leak is in the outer or inner skin and what caused the fault before deciding on an appropriate course of action. A leak in the inner skin, providing its position can be determined, can be repaired by patching or alternatively by relining the tank as above. A leak in the outer skin will necessitate replacing the tank or relining it with a double skin system where the interstitial space can be monitored. Where interstitial monitoring of double skin tanks has been installed, periodic checks of the alarm system should be carried out to ensure that it is working correctly. All repaired tanks should be leak tested following the repair and before being brought back into service.

7.3.3.5 Tank decommissioning

If decommissioning a tank it is important that it does not then become a potential source of pollution. The Environment Agency recommends that tanks which are not going to be used again are removed wherever possible. Where tanks are abandoned *in situ* they should be purged and filled with hydrophobic foam or concrete. For further information see Chapter 17 of APEA/IP *Guidance for the design, construction, modification and maintenance of petrol filling stations*.

Where tanks are water filled to make them safe on a temporary basis, the water level should be checked regularly to ensure corrosion induced leaks do not result in new releases of oily water to ground. **Tanks should not be permanently filled with water**.

As a site may have developed over 75 years, old tanks may have been decommissioned in the ground. In general decommissioned tanks should have been filled with solid material, but it is recognised that there may be some tanks buried either empty or even still containing product. Where a site has changed ownership many times, the most complete set of site drawings may be found with the Local Authority. If tanks are encountered during redevelopment works they should be probed by a suitably experienced contractor to ensure that they are stable and not an ongoing source or potential source of pollution.

7.3.4 Offset/direct fill pipes

Below ground offset or direct fill tank manchambers are prone to the accumulation of small amounts of product during delivery. If such manchambers appear oily on the surface of the walls, but do not accumulate significant product, then the walls may be leaking and require remedial work. Equally in areas with a high water table, if the chamber cannot be kept dry, then treatment to prevent egress of fuel may be required. The options for such works are described in section 7.4.3 for oil/water separators. Dependent on the outcome of the ERA an option may be to replace below ground offset fills with above ground offset fills, or to replace the manchamber with one which is water tight.

7.3.5 Delivery procedures

One risk reduction option is to ensure that delivery procedures include underground storage tank ullage checks to avoid the possibility of tank overfills. Overfill contingency plans should be based upon product dispensing, to avoid the high risk of spill from manually decanting delivery hoses after an overfill.

7.4 POTENTIAL PATHWAYS FOR POLLUTION

It is not possible to **prevent** certain types of spillage occurring during routine petrol filling station operations. The most frequent spills are customer refuelling incidents, spills caused by leaking car fuel tanks, spills caused during the filling of portable containers and spills during the filling of petrol filling station underground storage tanks, either directly, or by below or above ground offset fill points.

The concept of a 'pathway' from a source of pollution to an environmental receptor was introduced in Section 6. As stated in that Section, if there is not a source-pathway-receptor linkage then pollution will not occur. This Section gives details of pathways that can be identified and controlled at a petrol filling station. Where a pathway cannot be controlled, i.e. a permeable strata surrounding an underground storage tank, more emphasis will be placed on the equipment options previously described.

7.4.1 Forecourt surface quality

Areas susceptible to contamination, e.g. near pump islands or tanker off-loading points, should be impermeable to hydrocarbons and other liquids and should not allow seepage through or below the surface. Typically, concrete (recommended minimum 180 mm thick, laid in accordance with a recognised standard, e.g. BS 5328, and in the UK to The Specification for Highway Works), or similar highly impermeable materials such as sealed block paving will fulfil this requirement provided any associated jointing material is also impermeable and resistant to attack by motor fuel. Other areas may be surfaced with materials such as hot rolled asphalt, macadam, unsealed block paving, gravel, etc.

It should be recognised that **hard-standing areas do not remain impermeable over a long period of time**. They can be compromised by pipework repair, subsidence or wear and tear along pavement expansion joints. In general the extent of cracking, multiple joints and pavement subsidence are a good indication that potential contaminant pathways exist.

7.4.2 Controlling surface run-off by appropriate drainage

All forecourt surface areas where contamination is possible, e.g. pump islands and tank off-loading points, and any drainage apparatus which could receive contaminated water, should be contained by peripheral surface drainage channels or kerbs to divert all spills and runoff to an oil/water separator or constructed wetland. It is advantageous to use absorbent material to contain all surface spills. The drainage containment should be designed to provide an adequate number of channels and gullies so as to limit the surface travel of spilt hazardous products and prevent them reaching areas where surfaces are unprotected. Adequate containment of any contamination is required during routing to the oil/water separator or constructed wetland.

Where rodding eyes and manhole chambers for surface water are located in areas likely to be contaminated they should be double sealed to prevent ingress of fuel.

The catchment areas defined in Figure 5 should be designed to direct all run-off towards the drainage system in an efficient manner. Material and joints of channel drains should be designed to ensure that no leakage occurs and laid to gradients that will achieve self-cleansing flow velocities at design conditions.

Gratings should be installed which allow the run off to be intercepted and freely to enter the channel. Channel gratings should be continuous and uninterrupted. Channels and gratings should be installed and tested to manufacturer's instructions. All outlets should be trapped, accessible and easily maintained.

When considering the design of drainage pipework, the rainfall, proximity of high buildings and levels of surrounding land should be considered. The drainage pipework should be:

- Sized to suit the storm return periods appropriate to the location and in accordance with the requirements of BS 6367 and **capable of transporting a spillage from the tanker standing area at a rate of at least 15 litres/second.**
- Resistant to the effects of light hydrocarbon liquids when tested as specified in prEN 858-1.

The access and egress cross over points are normally protected by a channel line drainage system set at least 300 mm into the site, and 50 mm below cross over level. **This will prevent the flow from any spillage on the forecourt, not otherwise routed to drainage, going beyond the curtilage of the petrol filling station.** Additional drainage is not required where cross-over points are at a higher level than the operational areas of the forecourt.

A penstock or other suitable valve should be installed in the first manchamber downstream of the oil/water separator capable of shutting off all flow and assisting the prevention of contaminated effluent leaving the site during maintenance or emergencies. Where a constructed wetland is used instead of an oil/water separator it should be fitted with an automatic shutoff valve which will close in the event of a spill, see 7.4.3.1.

All drainage channels and systems should be installed and maintained in accordance with manufacturers' instructions.

Foul sewer water disposal is the most common discharge route for effluent disposal, as highway drainage usually discharges directly to water courses without treatment. In the UK it is a legal requirement for all discharges of trade effluent to be authorised by the local sewerage undertaker.

Disposal of effluent to controlled waters in the UK is authorised by the Environment Agencies.

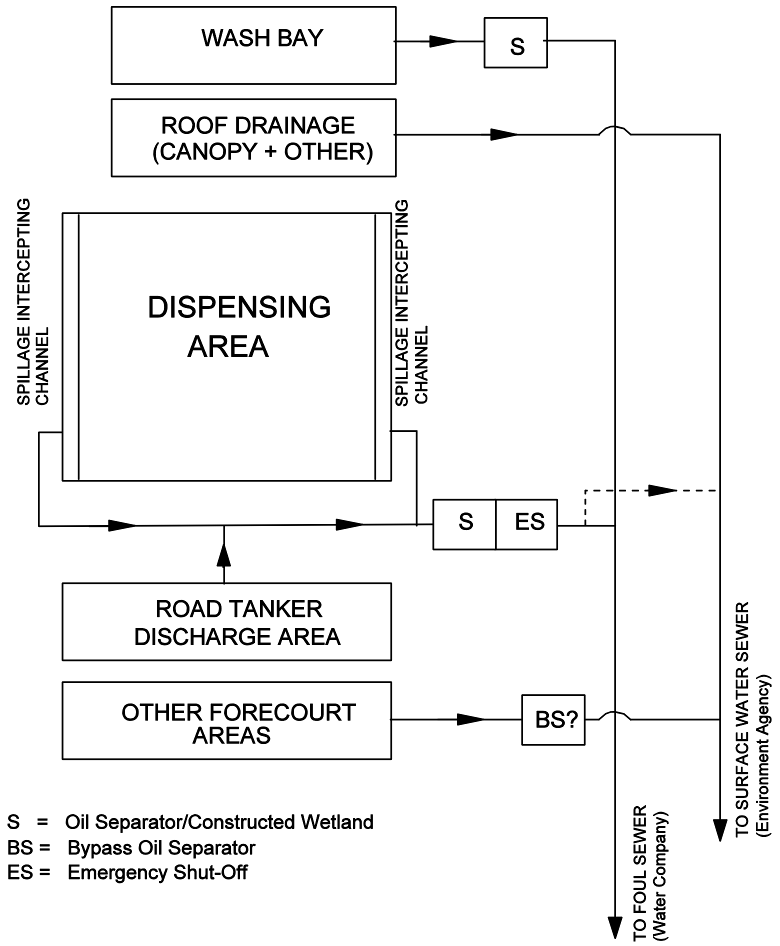

Figure 5 – Typical discharge arrangements for petrol filling stations

In the UK soakaway discharges must also be authorised under the Water Resources Act 1991 and the Groundwater Regulations 1998. Prior to 1999 the EA in England and Wales did not generally seek authorisations for the discharge of effluent from surface water drainage systems (including soil/water separator discharge) to controlled waters on petrol filling stations. However this legal requirement is now being actively enforced. Authorisation for a petrol filling station soakaway in Source Protection Zone 1 (50 day water travel time) or Source Protection Zone II (400 days) of a drinking water abstraction will be resisted by the Agency, and only allowed under strict control in Source Protection Zone III which represents the wider catchment area.

7.4.3 Oil/water separators

7.4.3.1 General

Oil/water separators act as a potential pathway from a source of pollution to a receptor. Where separator chambers are unable to hold water due to porous brickwork or damaged pointing, the oily effluent will soak into the surrounding ground. Options for such chambers include upgrading to a new model, relining with GRP, re-pointing or injection grouting. Dependent on the outcome of the ERA an option to assist increasing capacity and effectiveness is to add an additional chamber. For further information on use and design of oil/water separators see EA PPG3 *Use and design of oil separators in surface water drainage systems*.

The limitations of oil/water separators should be recognised when designing a drainage system. They do not treat dissolved phase hydrocarbons and their performance in the field is likely to be inferior to that stated by the manufacturer (which relates to test conditions). If the receiving surface water is environmentally sensitive then some form of additional/alternative treatment may need to be considered such as a constructed wetland. A wetland with reeds *Phragmites spp.* enables bacteria around the roots of the plants to biodegrade any hydrocarbons, so that there is no long-term accumulation of product. This results in an improved quality of water leaving the site, with potentially less on-going maintenance compared with an oil/water separator. For details of the safety considerations required if installing a constructed wetland see HELA PETEL circular 65/45 *Petrol filling stations – Surface water drainage – Constructed wetlands*.

7.4.3.2 Design

Oil/water separators are designed, under ideal conditions to prevent hydrocarbons from leaving the site and to also reduce the quantity of grit and silt in the effluent. Separator capacity should be determined by:

- the drainage capacity feeding the unit;
- separator performance required;
- the likely size of a spill.

In general 3000 litre units are adequate for petrol filling stations.

Older oil/water separators are generally two or three-chambered brick structures that should contain the hydrocarbons in the first chamber. If hydrocarbon is visible in the third downstream chamber the unit should be cleaned by a waste contractor. In heavy rain (high flow) the effectiveness of an oil/water separator is considerably reduced. There is also a tendency for the first chamber to act as a grit arrestor and unless it is cleaned regularly, the outlet to the second chamber will become obstructed thereby reducing the efficiency of the unit.

Modern oil/water separators are generally single chamber GRP units, making visual assessment more difficult as the unit will still function when there is visible product in the main chamber. As a rule all units should be visually inspected every 6-12 months and cleaned where necessary. Records of inspection and maintenance should be kept. The cleaning frequency may be reduced where biological treatment is added regularly. Modern units may be fitted with coalescing filters and automatic shut-off valves. It is also possible to install hydrocarbon sensors in oil/water separators that are linked to the site petroleum gauging system. This allows the continuous monitoring of the unit for the presence of fuel. Where units discharge to highly sensitive watercourses the alarm may also be connected to remotely actuated shutoff valves.

The waste water from automatic vehicle washes, high pressure hand washes and steam cleaners produces large volumes of water, possibly at high temperatures, which are contaminated with detergents, oil and road dirt. The wide range of cleaning detergents used in the washing process can form stable emulsions. These emulsions take time to 'break' and separate into the oil/water phases, therefore this type of effluent should not be regarded as a trade effluent and **managed in a totally separate drainage system to the one used to drain the forecourt to an oil/water separator**. Wherever possible the car wash water should be re-circulated.

Note: Under no circumstances should waste water from vehicle wash facilities be discharged through the forecourt oil/water separator. Such action will reduce the separator's effectiveness.

All roof drains which collect clean, uncontaminated water may be routed to bypass the oil/water separator to avoid otherwise reducing the capacity of the unit to contain a spill. In order to mitigate urban runoff it may be preferable to reclaim this clean water for use in the sales building or for valeting operations, or use to recharge groundwater through soakaways if this is acceptable to the Environment Agency.

7.4.3.3 Cleaning

The cleaning operation should include pressure washing of the surface gullies on site to ensure they are free of debris.

The frequency of cleaning may be reduced where the oil/water separator only receives rainwater runoff from the peripheral pavement areas or the canopy, and is therefore unlikely to contain hydrocarbons.

The most effective, and preferred, method of cleaning an oil/water separator is by purging. This requires the uplift and disposal of all liquid and sludge in the unit and then re-filling with **clean water**. Previously a decanting method was also accepted as an adequate cleaning process. This involved the uplift of the separator contents to a vacuum tanker, where it was allowed to stand for at least one hour. After allowing the sludge to settle in the base of the tanker and the free oil to rise to the surface the effluent water could then be decanted from the middle of the tanker, back to the separator. In practice this separation is difficult to achieve and fine particles of silt and dissolved oil will be returned to the separator. The decanting method is not recommended, but if used, site operators should be aware that 10 ppm oil can easily be returned to the separator, necessitating further cleaning within a relatively short period of time. If decanting is used the separator must be isolated from the downstream drains during the operation to prevent overfilling and discharge of grossly polluted effluent.

All peripheral drains on the forecourt should be pressure washed clean as part of the same operation.

Oil/water separators should be re-filled with clean water as soon as the cleaning operation is complete. Under no circumstances should rainfall runoff be relied upon to refill a separator.

Coalescing oil filters should only be removed for cleaning when the unit is empty to avoid damaging the filter. The effectiveness of sensor probes, valves and alarms should also be checked periodically as the unit will be ineffective without a water seal.

7.4.3.4 Inspection/maintenance

It is of utmost importance that oil/water separators are regularly inspected and routinely maintained according to the manufacturer's recommendations. The frequency should be determined by site conditions but as a minimum inspection is recommended every six months.

Forecourt maintenance which involves degreasing either by steam cleaning or using a solvent or a combination of both must be carried out with the shutoff valve downstream of the oil/water separator, if one is installed, in the closed position to prevent escape of contaminants. It is essential that the oil/water separator is cleaned out before the valve is reopened.

Modern oil/water separators can be fitted with hydrocarbon sensors and alarms to indicate the presence of fuel, and the need for non-routine maintenance.

Oil/water separators should always be inspected after a spill, see Section 12.

7.4.3.5 Disposal of oily waste and sludge

In the UK, producers of waste have Statutory Duty of Care to ensure wastes are properly disposed of. Waste from oil/water separators and oily waste liquid from tank man-chambers is generally classified as Special Waste requiring advance notification of transport and disposal. This should be arranged with the Environment Agencies[4], by the waste contractor three days before collection, along with the provision of a consignment note. The producers should ensure that the waste contractor is registered with the Environment Agency and should satisfy themselves that the waste is properly dealt with.

Where effluent testing in advance of collection can be carried out, and the flash-point of the material is >21 °C and the benzene content <1000 ppm, then the effluent can be demonstrated not to be Special Waste. However the cost and delay caused by such testing should be compared to the costs of disposal. In practice only sludges from oil/water separators dedicated to car wash effluent are likely to be non-Special wastes.

In the UK a waste transfer note must be supplied to comply with the Duty of Care regulations under Section 34 of the Environmental Protection Act 1990. Special Waste transfer documents should be kept indefinitely and all other transfer notes for two years.

Except in an emergency following a spill, all cleaning should be notified to the Environment Agency in advance of the work. Where the contractor carries out the work without advance notification both the contractor and site operator are contravening UK legislation.

The Duty of Care transfer note supplied by the contractor should include an Enviroment Agency manifest number.

[4] Environment Agency, http://www.environment-agency.gov.uk/?lang=_e (0345 001166)
SEPA, http://www.sepa.org.uk/

8

DETECTING LOSS OF PRODUCT

8.1 WETSTOCK MONITORING/LEAK DETECTION

The source of a leak or spill is not necessarily a good indicator of the potential spill size. The accuracy of stock monitoring and other leak detection techniques is critical to detecting leaks at an early stage. It follows that a larger quantity of product may leak to soil and groundwater from a long running undetected pipework leak than from a catastrophic failure of an underground tank.

It should also be recognised that any leak detection system is only as good as its detection limit and the standard to which it is maintained and operated. Poorly maintained leak detection systems may have severely impaired performance, or in some cases may not be detecting leaks at all. Leak detection standards vary according to the variety of method used, as shown in Table 5:

- Current standards for mechanical and electrical leak detection systems accredited by the US Environment Protection Agency (EPA) set tank leak detection limits ranging from 9 – 50 litres per day (lpd).
- US EPA Statistical inventory reconciliation (SIR) standards are 7-9 lpd for pipework and storage tanks.
- EN Class 4A & 4B1 automated reconciliation standards 50 lpd.
- Proprietary reconciliation services are available with detection limits of 0,1 % throughput, equivalent to 5 – 20 lpd depending on the throughput of the site.

The following sections from IP/APEA *Guidance for the design, construction, modification and maintenance of petrol filling stations* are included to provide guidance on the main types of leak detection systems available and some of the factors that should be considered when deciding on the type of system to give the appropriate level of environmental protection for the identified risks. An effective leak detection system should provide early warning of a potential problem so as to enable prompt corrective action to be taken. Careful consideration should be given to the fail-safe qualities of any leak detection system, to ensure that the surrounding environment remains properly safeguarded in the event of component failure or inadvertent disabling of the system. Leak detection systems are split into classes as shown in Table 5.

The classes described in Table 5 are mainly derived from the draft European Standard for Leak detection systems prEN 13160 (Parts 1-7). Some changes and additions have been made which are of particular relevance in the UK.

Table 6 provides a brief summary of the various classes of system currently available, their method of operation, detection capability and effectiveness. The performance standards referred to as classes 1 to 5 are specified in prEN 13160-1. One means of demonstrating the performance capabilities of any of these classes of leak detection systems is certification by an independent test house.

Table 5 – Classes of leak detection systems

Class	Method of operation	Detection capability	Effectiveness
1	Monitors air pressure or vacuum between the skins. Alarms if pressure changes	Detects leaks anywhere in double skin equipment, irrespective of product level	Very secure system. Alarms before product can reach the environment
2	Monitors pressure of a liquid filling the gap between the skins	Detects leaks anywhere in double skin equipment, irrespective of product level	Very secure system, alarms on any leak. External leak loses fluid into ground
3	Detects the presence of liquid or hydrocarbon vapour within the interstitial space	Detects leaks in double skin equipment with large interstitial space	Liquid sensors at low points. Vapour sensors unable to detect failure of outer skin
4	Analyses rates of change in tank contents. Three sub-classes possible	Detects leaks below liquid level in tanks and pipework	Product released to the environment before a leak is detected
4 a Dynamic	Automatically compares change in tank contents with volume of product dispensed	Detects leak anywhere in tank or pipework below liquid level	As for Class 4. Does not detect leaks above liquid level
4 b (1) Statistical quiet period	Monitors tank contents over the periods when no product is being dispensed	Detects leak in tank below liquid level	As for Class 4a but does not detect leaks in product line. Only operates whilst no product is being dispensed
4 b (2) Static	Monitors as for 4 b (1) but for longer periods of time	As for 4b(1)	As for Class 4b(1) but requires long quiet period
5	Uses monitoring wells round the site to detect released product	Detects leaks below the liquid surface level in tanks or pipework	As for Class 4
6	Change in tank contents and metered sales taken manually are reconciled	Detects leaks below the liquid surface level in tanks or pipework	As for Class 4
7	Applicable only to pipework		

The choice of system for any particular application will depend upon the circumstances at a site and its surrounding environment. The risks of damage to the environment should be assessed, and the higher risk taken as the design criterion. This, together with a consideration of the type, condition, and inherent security of the installation to be protected, and applying the test of reasonable practicality, will enable an appropriate system to be selected for the assessed risks.

The guidelines in Table 6 provide information on the classes and methods of leak detection suitable for various elements of an installation which may require such protection. They are intended to assist the operator in making informed decisions as to the most appropriate system for the circumstances and risks associated with each site, which will vary depending upon the effect a leak would have on the surrounding area.

The inclusion of particular systems or methods in the table does not imply that these should always be used; they are intended as illustrative guidance only and there may be other equally suitable systems available. Conversely, some systems are not suitable in all circumstances, for example monitoring wells are ineffective in heavy clay soils. Ultimately, it is for the operator to determine, and where necessary justify, the most suitable system in the particular circumstances of each case. The column headed 'Severity of impact of a leak' is intended to allow for variations in the effect of a leak on the surrounding area from an environmental (and safety) standpoint. The severity of impact is divided into high, medium or low but there may be gradations between these, and each case should be considered in the light of its particular circumstances. In some instances, no adequate leak detection system is available and this is indicated by the words 'none available' appearing in the table. On the other hand, it may not be necessary, in some instances, to consider any form of leak detection at all. In such cases the words 'not necessary' appear in the table.

For further information on the classes and methods of leak detection for new installations (including complete redevelopment), and for a description of each of the system classes, see IP/APEA *Guidance for the design, construction, modification and maintenance of petrol filling stations*. The guidance for new installations recognises that they will generally be provided with a high standard of protection. Such systems may not always be reasonably practicable for existing installations. Further information on assessing the risks and deciding on appropriate standards is given in HS(G)146 and IP *Guidance on risk assessment for the water environment at operational fuel storage and dispensing facilities*. Additional information can be found in HELA LACOTS PETEL 65/34, October 2000.

To minimise the environmental impact from leaks and spills, good stock reconciliation and operation are critical. Wetstock should be reconciled daily and reviewed weekly.

Table 6 - Typical systems for existing installations
(Note: For older elements the more secure class should be selected)

Element to be monitored		Severity of impact of a leak			
		High	**Medium**	**Low**	**Notes**
A. Tanks					
Steel	- single skin	class 4a	class 4b(1) or 4b(2)	class 6	
GRP	- single skin	class 4 or 5	class 4 or 5	class 4 or 5	
Steel, GRP, composite	- double skin or old tank refurbished as double skin	class 1 and 5 or 2 and 5	class 1 or 2	class 2	1
B. Product pipework					
Pressure system	- single skin	None available	class 4a and 7	class 7	2
	- double skin	class 3 and 7	class 7	class 7	
Suction system	- single skin, check valve at tank	class 5	class 5	class 6	
	- single skin, check valve at dispenser	class 6	class 6	class 6	
	- double skin	class 3	class 4a	class 6	
Siphon system	- single skin	class 5	class 6 or none	not necessary	
Off-set fill	- single skin	class 5	not necessary		
	- double skin	class 3	not necessary		
C. Vapour pipework					
Vent	- single skin	overfill prevention devices		not necessary	
Stage 1b or 2	- single skin	class 5	not necessary		3
	- double skin	class 3	not necessary		3
D. Sumps and chambers					
Dip, fill, changeover valve chambers, sumps beneath dispensers, etc		class 3	not necessary		

Notes:
1. Where it is assessed that the impact of a leak on the surrounding environment would be high, a class 1 system will be most appropriate; elsewhere, class 2 may be adequate.
2. Single skin pipework is not recommended for use with pressure systems in locations where there would be a high environmental or safety impact resulting from a leak.
3. Stage 1b and 2 Vapour Recovery installation should be designed to preclude the possibility of liquid hydrocarbons entering the vapour lines. Where this is achieved, leak detection is not necessary and single skin pipework will be adequate even in situations where the impact of a leak will be high. However, where this cannot be avoided, the stated leak detection systems are recommended.

8.2 TANK/PIPEWORK TESTING

It should be noted that the operation of an appropriate leak detection system can obviate the need for regular tank/pipework integrity testing. Where a leak is suspected the tank and/or pipework should be tested using a method appropriate to the installation.

In the absence of UK, European or petroleum industry standards, the tank testing methods are generally certified as meeting the requirements of the United States Environmental Protection Agency (EPA) *Standard test procedure for evaluating leak detection methods*. Certification will be from an accredited EC or US test house that will issue a Certificate of Conformity for the system.

The requirement of the EPA protocol is for a tank testing system to detect a leak rate of 380 ml/hr or more within a 95 % probability of detection accuracy whilst operating a false alarm rate of 5 % or less.

It should be recognised that it is therefore possible for tank/pipework to 'pass' an integrity test in accordance with the EPA protocol, but still be releasing up to nine litres per day of product into soil and groundwater. Given the legal obligations and depending on the outcome of the ERA for the site, the site operator may wish to seek guidance from operators of the testing system as to the actual leak detection threshold achievable by the method.

It is recommended that test methods based on precision testing techniques should be used wherever possible. Such forms of testing take account of the many uncontrolled variables which a simple hydrostatic test cannot. They are therefore more reliable and have a greater probability of identifying a leak than the latter.

Precision tests generally fall into one of two broad categories:

(a) **Volumetric Methods** use techniques which detect any change in height of liquid in the tank to define a leaking or tight tank. Typically such tests provide a measurement of the actual leak rate if any.

(b) **Non Volumetric Methods** do not rely on detecting a change in height measurement to determine a leaking or tight tank, and typically provide a pass or fail result. Examples of this type of test are those applying a vacuum and/or pressure to the tank, those using chemical trace elements or mass measurement.

Method statements and operating protocols should always be available with precision test methods. These are necessary to ensure that the appropriate test considerations and qualifications pertinent to such tests are fully addressed at the time of testing. The method statements should clearly identify particular factors that have to be considered and which may affect the accuracy of the test including:

— water table measurement and compensation;
— positions of sensory probes within or outside the tank in order to detect leakage;
— procedures for testing multi-compartment tanks;
— minimum certified product levels for testing;
— compensation for climatic conditions at the time of test;
— stabilisation periods for equipment or product to eliminate temperature effects;
— process to compensate for fuel vaporisation in the ullage space;
— means of detecting both leaks of product out of, and entry of water into, the tank.

Operators of tank/pipework testing systems should demonstrate that the operating criteria specified by any certification, including any limitations, are strictly adhered to. If for any reason a test is conducted under conditions outside the limitations of the evaluation certificate, the test report will need to state the limitation(s) that have been exceeded together with details of any supporting calculations or increase in the data collection period etc. to confirm that the test complies with the EPA protocol.

Additional information can be found in HELA LACOTS PETEL 65/34 *Leak detection in tanks and pipework*, October 2000.

8.3 APPARENT LOSSES

Losses of product are often indicated by stock reconciliation systems. Upon investigation it may be determined that losses are not caused by leaks. Dispenser meters should be checked periodically and other sources of loss e.g. theft, faulty gauge probes etc. should be considered. The elimination of apparent losses should improve business performance and improve the leak detection capability of the systems in use.

Recommended Interval for Meter Audit:

All dispenser meters – at least once every three years. Sites with high throughput (>5 m lpa) - one to three times per year or as suggested by wetstock analysis.

8.4 TESTING EFFLUENT QUALITY

Testing of effluent quality is not currently routinely carried out at petrol filling stations in the UK. On 'sensitive sites' or following a reported incident, the Environment Agency may require monthly or annual samples. Where oil reducing bacteria are dosed to the oil/water separator to reduce the cleaning frequency then quarterly samples should be taken to ensure the dose rate is adequate.

The testing suite should include the following as a minimum requirement:

— total petroleum hydrocarbons;
— benzene, toluene, ethyl-benzene, xylene (BTEX).

9

EMISSIONS TO AIR

9.1 GENERAL

Petrol is a volatile liquid and gives off vapour even at very low temperatures. More vapour is given off as the temperature increases. Vapours released from petrol lead to the formation of damaging ozone in the lower atmosphere. A build up of ozone in the lower atmosphere adversely affects human and animal health, interferes with plant growth and damages building materials. It can also cause photochemical smog which is detrimental to the respiratory system.

Releases of product from site to air, will be either through vents, dip tubes or pipework maintenance. These releases may be planned, such as during maintenance and dispenser calibration, and unplanned releases from leaks and spills.

9.2 VAPOUR RECOVERY

9.2.1 Stage 1b

When a road tanker off-loads petrol into the underground storage tanks at a petrol filling station, the vapour in the tanks is displaced by the incoming petrol and a vapour space is created in the tanker compartment. The following diagrams illustrate what happens before and after the installation of a Stage 1b system:

Without vapour collection
Without vapour control equipment the vapour displaced from the underground storage tank is vented to atmosphere, and the space created in the tanker compartment is filled with fresh air drawn in via the P/V valve on the tanker.

With vapour collection
With vapour control equipment, the vapour vents from the underground tanks are connected back to the delivery tanker. In this way, as petrol flows out of the vehicle, the vapour present in the underground tanks is routed back to the vehicle compartment. To stop the vapour going out to atmosphere, the tank vents are fitted with pressure/vacuum valves (P/V valves) which maintain a small back pressure in the system. This, together with the negative pressure in the road tanker, encourages vapour to flow back to the vehicle compartment. This process is shown in Figure 6.

As the volume of vapours displaced is roughly balanced by the volume of product discharged, the concept is known as 'vapour balancing'. However, it should be noted that vapour can be generated during the off-loading process which can affect the overall system efficiency. Vapour generation can arise from the turbulence caused by fuel and air entering the tank, and by relatively warmer fuel from the road tanker mixing with cooler fuel in the underground storage tanks.

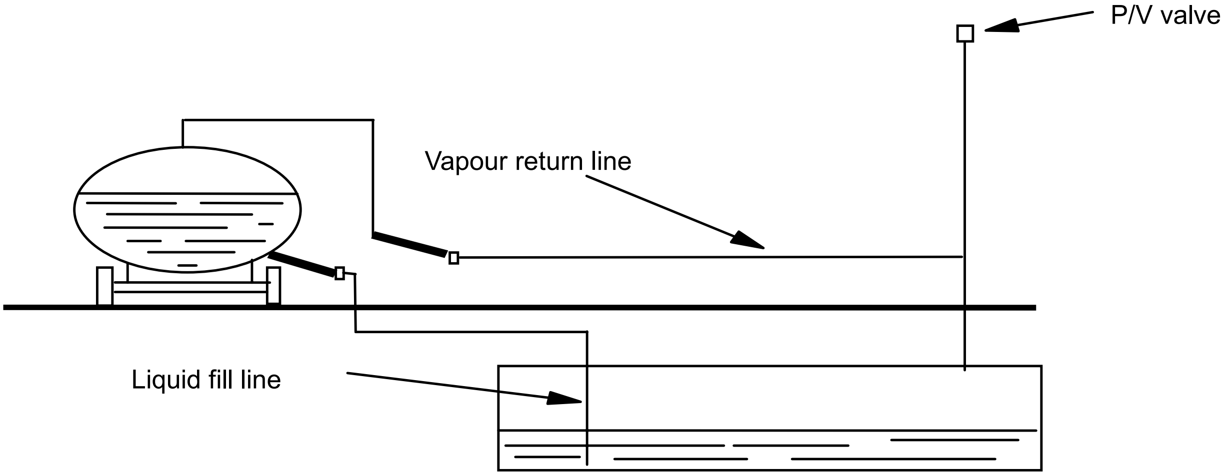

Figure 6 – With vapour collection

The achievement of a satisfactory return vapour flow from underground storage tanks to the road tanker compartments is dependent on minimising the resistance to flow at all stages of vapour transmission, and minimising the generation of additional vapour. This must be a primary consideration when designing or retrospectively introducing a vapour balancing system. The aim is to induce the vapour to flow preferentially from the underground storage tank to the road tanker rather than through the filling station vents to atmosphere.

High emission control efficiencies can only be achieved with this system if it is correctly designed with particular attention being paid to component selection and installation.

9.2.1.1 Changes required to an existing installation

Any modification to existing pipework must be approved in advance by Petroleum and Environmental Health Officers. All changes should be noted on site drawings, on new pipework and in chambers. If diesel tanks remain manifolded to tanks with vapour recovery, they should be treated as petrol tanks for road tanker deliveries and maintenance purposes.

Installation of a vapour balancing system to an existing filling station is likely to require the following major changes (note, for a new station these facilities would be designed in from the beginning):

1) The addition of a vapour return pipework system to route the vapour back to the road tanker and modifications to the storage tank vent system, including the addition of a vent emission control device.

2) Provision of a vapour connection at the filling point for returning vapours to the road tanker.

3) Provision of vapour transfer hoses. Generally these will be carried on the tanker but in some cases may need to be stored securely at the petrol filling station.

Note: The condition of the existing fill and vent pipework installation should be checked in order to determine which design options are most suitable for a particular filling station. It is important that a check is made to determine if there are any leaks or restrictions in either the liquid fill system or the vapour vents.

The requirement for petrol vapour recovery at stations is derived from Section 7(2) of the Environmental Protection Act 1990 in the UK and the VOC Directive 94/63. The detailed requirements of the UK legislation are given in the Secretary of State's Guidance PG1/14 (96). This requires vapour recovery to be installed to a timetable based upon the throughput if the station, with all sites to be licensed have equipment installed by 31/12/2004.

By each relevant deadline the site must hold an authorisation for vapour recovery issued by the Local Authority environmental health department in England & Wales and by SEPA in Scotland. In some areas the duty for periodic regulatory inspection may be carried out by local petroleum officers on behalf of the EHO. Authorisations are renewable annually for a fee.

The regulations require the installation of vapour recovery pipework and manifolds, pressure/vacuum valves on petrol tank vents, delivery procedures and a regime of regular inspection and maintenance. It should be noted that all substantial alterations to fuel storage infrastructure require notification to the EHO, as well as the PO. Alteration of tank grades between diesel and petrol or new tanks should be pre-notified. The requirement for record keeping can usually be met through modification of the site petroleum register to include forecourt inspection and maintenance. Model procedures and records can be found in PG1/14 (96).

9.2.2 Stage 2

The emission of VOC is regulated at European level by EC Directive 94/63 and enacted in the UK by Part 1 Environmental Protection Act. There is currently no legal requirement for nationwide Stage 2 vapour recovery. However, Local Authorities are obliged to carry out air quality assessments and these may require the installation of Stage 2 equipment as a local air quality improvement measure.

9.2.2.1 Basic principles

As vehicles are being filled on the forecourt, vapours are displaced by the fuel entering the vehicle tank and at the same time a similar vapour space is created in the underground storage tank. The following diagrams illustrate the situation before and after the installation of a Stage 2 system.

Without Stage 2

Where there is no Stage 2 system, vapours displaced from the car's petrol tank are vented direct to atmosphere and fresh air is drawn into the underground tank via the vent pipe.

With a Stage 2 system

With Stage 2 systems a special nozzle collects vapour from the car fill pipe instead of allowing it to vent to atmosphere. The vapour may be returned to storage, vented via a filter or burned off in an incinerator unit. A vacuum pump may be situated in each dispenser housing or there may be a single central pump at a remote location. This arrangement is shown in Figure 7.

9.2.2.2 Changes required to existing installations

The introduction of a Stage 2 system requires some or all of the following modifications to be made to an existing installation:

- use of a special refuelling nozzle and ancillary fittings;
- introduction of a vapour return hose on the dispenser connecting the nozzle to the vapour piping;
- additional pipework to return vapour from dispenser to storage tank;
- additional equipment installed within the dispenser or at a remote central location. This will be influenced by the method adopted for achieving vapour flow back to the storage tank;
- a Stage 1b system unless already fitted.

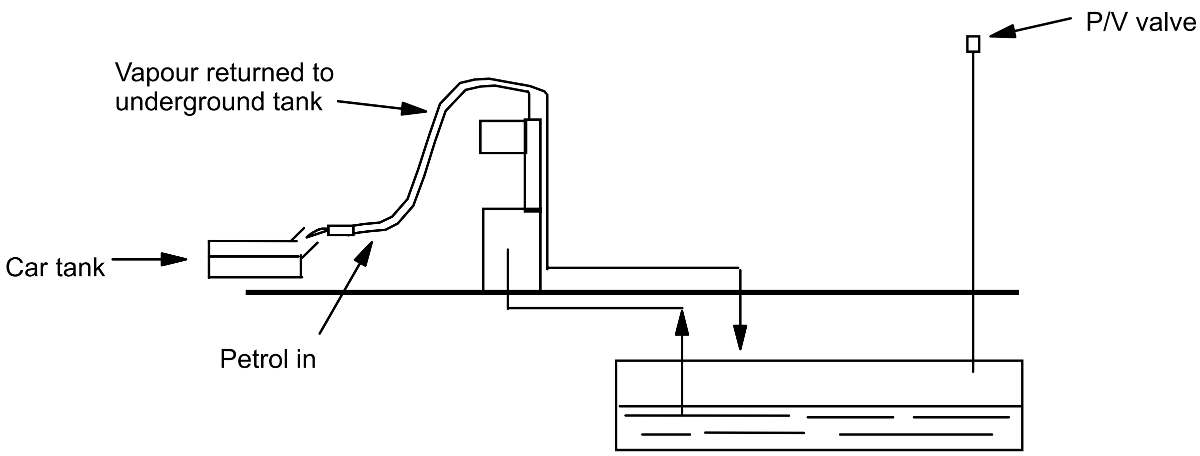

Figure 7 – With Stage 2

9.2.2.3 Types of vapour return system

Two established methods of collecting and returning vapours for Stage 2 operation currently exist. These are known as active (open) and passive (closed or balance) systems. Other systems, such as those using refrigeration techniques to produce liquid condensate at the petrol filling station, may be available but are not covered here.

The active system employs a vapour pump to assist return vapour flow from the vehicle fuel tank to the supply storage tank. The vapour pump may either be installed and driven from within the dispenser or be located remotely from it, in which case it is generally referred to as a centralised system.

The passive system relies on the pressure generated when dispensing petrol into the vehicle fuel tank to force the displaced vapours back to the filling station storage tank. It requires a good seal on the nozzle to prevent vapour from escaping to atmosphere. In some cases the provision and action of this seal can make the nozzle clumsy and difficult to use. In consequence passive systems have not been installed as extensively in Europe as the active systems.

Any equipment used should hold an appropriate safety and performance approval, either as components or as a complete system, by the appropriate authorities in an EU member state which has enacted national Stage 2 vapour control legislation.

It is important to ensure that retrofitting of a vapour collection system into an existing dispenser does not compromise the relevant certification of that dispenser.

10

MANAGEMENT OF CONTAMINATED SITES

10.1 SOIL AND GROUNDWATER CONTAMINATION

Operation of petrol filling stations over a long period causes a build-up of vapour at a shallow depth below the forecourt pavement area, mainly from customer spillage. This is generally of little environmental significance and is characterised by vapour in the upper 1 m of the ground at levels of up to 50 ppm. The amount of contamination may increase due to:

— cracks in surface pavement;
— leaks from oil/water separator chambers;
— spillage to direct fill tank manchambers;
— spillage to above or below ground offset fill chambers;
— dispenser leaks;
— pipework leaks;
— offset fill line leaks.

Deeper contamination may be caused by migration of contaminants through shallow ground or by tank leaks. Where the water table is found less than three metres below the surface then downward migration of contaminants is more likely.

In addition site operators may need to consider contamination issues for a number of other reasons, e.g:

— during the commercial acquisition or disposal of land used for petroleum retail purposes;
— short-term incidents;
— as part of a normal tank refurbishment/site redevelopment programme;
— in response to complaints from neighbours of smells of petrol and/or about the presence of petroleum products thought to have migrated onto their land;
— in response to a company's contaminated land risk management policy;
— in response to the requirements of regulatory authorities.

In any of these circumstances, a retail site operator may need to investigate and assess his land for the presence of any contamination which could cause unacceptable risks, and to take remedial (or corrective) action to reduce or control these risks.

10.2 LEGAL REQUIREMENTS

In the UK, there are several pieces of legislation which can be relevant to land contamination. The term contaminated land is in this case used in its general sense, and hence is intended to include contamination of ground and surface waters.

Typically (but not always, or exclusively) petroleum retail sites may be affected by:

— planning and development control legislation;
— water legislation, such as the Water Resources Act 1991; Groundwater Regulations 1998;
— waste legislation, including the Duty of Care provisions of the Environmental Protection Act 1990 [EPA];

— Part IIA of EPA 1990 (introduced by section 57 of the Environment Act 1995).

UK policy on contaminated land requires the adoption of a balanced and risk-based approach to dealing with contamination, which is compatible with the general principles set out in the DETR's *Guide to risk assessment and risk management for environmental protection*, and consistent with the principle of sustainable development. Current policy is committed to the 'suitable for use' approach, taking into account the costs and benefits associated with any action. This means that the significance of any contamination found, and the need for any remedial action, should be assessed in the light of the current use and/or proposed use, where applicable, of the land.

In the UK Part IIA of the EPA sets out a statutory regime for contaminated land management, implemented through Regulations and Statutory Guidance. This covers the identification and control of land which, under its existing use, poses a threat of significant harm or pollution of controlled waters because of the contamination present. Part IIA is not relevant where a change in land use or development is planned which requires planning permission - in these cases, existing planning and development control legislation will apply. Under Part IIA, local authorities are required to inspect their areas and identify land which falls within a new statutory definition of contaminated land:

"Contaminated land is any land which appears to the local authority in whose area it is situated to be in such condition, by reason of substances in, on or under the land, that:

— *significant harm is being caused or there is significant possibility of such harm being caused; or*
— *pollution of controlled waters is being or is likely to be caused."*

Where land is identified as contaminated in this way in the UK, the regulatory authority (either the local authority or the Environment Agency or Scottish Environment Protection Agency [SEPA]) is required to identify appropriate persons, and to reach agreement with them that appropriate remediation is to be carried out. This can be carried out on a voluntary basis which is by far the preferred option, as under such circumstances the site owner has greater freedom over the choice of remedial action employed. In some cases, where agreement is not possible, the Regulator will serve a remediation notice requiring specified action to be carried out.

Sites subject to a remediation notice will be listed on a public register. Appropriate persons are defined as those who are responsible for causing the contamination, or for allowing it to remain in place (which could include the site owner or occupier if they were aware of the presence of contamination e.g. through a spill, but did nothing about it), or in the event that these persons can not be found, the site owner or occupier. [Note that the site owner or occupier is not held responsible for water pollution unless he caused the pollution or knowingly allowed it to remain, or unless he acquires 'class A status' by acquiring the property with knowledge of its (contaminated) condition.]

It may be the case that the site operator has insufficient resources or the specialist knowledge to carry out this work, and hence needs to employ suitable advisors/consultants and/or contractors to undertake it. Whether an operator does the work himself or appoints experts, the investigation, assessment and remedial treatment should be carried out in accordance with good technical practice.

10.3 PROCESS OF MANAGING CONTAMINATED LAND

A risk based approach, as described in section 6, should be adopted to identify risks from contamination, assess the significance of them and take action to deal with any which are unacceptable. For further information see IP *Guidance document on risk assessment for the water environment at operational fuel storage and dispensing facilities.*

In the UK, the Department for Environment, Food and Rural Affairs (DEFRA) has published a series of model procedures for managing contaminated land, see Annex D. This procedural guidance relies on the risk based approach to assessing and managing land contamination, and is intended to be applicable to a wide variety of types of contaminated site. The approach adopted by the petroleum industry to dealing with contamination is generally consistent with the Department's model procedures.

The process of managing contaminated, or potentially contaminated, land involves following a logical sequence of steps or activities. These are summarised following and in Figure 8.

1. Establish why the work has to be carried out, and set objectives

— provides the focus and context for the activities to be carried out;
— context and objectives will always be site specific;
— objectives will influence the amount and type of data to be collected;
— influences decision of whether to carry on with further work at the site or whether it is acceptable to stop.

2. Carry out a preliminary assessment of the site

— both qualitative and quantitative risk reviews are possible to develop a conceptual model of sources, pathways and linkages at the site;
— a qualitative approach to identifying pollutant linkages may not satisfy all parties involved.

3. Carry out site investigation(s)

4. Estimate and evaluate the risks from contamination at the site

5. Decide on appropriate risk management options

6. Where appropriate, implement remedial measures and carry out testing/monitoring to validate their effectiveness

7. Implement long-term monitoring and maintenance measures, if necessary

It will not be necessary to carry out all steps of the process at all sites. Depending on the site conditions, it may be possible to stop at the end of step 2, or at the end of step 4. However, the amount of information available about a site at the end of step 4, is much greater than that obtained by step 2. It should be noted that both qualitative and quantitative risk reviews are possible, and a thorough and considered use of the former will often reduce the need for the more detailed quantitative approach. However, in some circumstances, it may be difficult to persuade other parties, such as regulatory authorities for example, that stopping the process at the end of step 2 is sufficiently safe and protective of health, safety and the environment.

It is necessary to follow the steps sequentially. For example, it is not normally possible to decide on appropriate risk management options (step 5), without having first completed steps 1 to 4. However, in many cases there may be iteration, both within individual steps and between them. Iteration is commonly practised between step three, site investigation, and step four, estimating and evaluating risks, with more data being collected to enable risk estimates to be refined.

For greater detail on the above steps see IP *Guidelines for investigation and remediation of petroleum retail sites*.

Whilst site operators will normally be able to collect much of the information needed for a preliminary site assessment, the interpretation of this and any further investigative work may not be straightforward, and will require additional expertise. Subsequent stages of site investigation, risk estimation and evaluation, and risk management will normally be carried out by, or in conjunction with, specialists. Site operators/owners may wish to refer to the following background publications to assist them in understanding further the technical process of dealing with contaminated land:

— Institute of Petroleum's Code of Practice for the *Investigation and mitigation of possible petroleum-based land contamination*
— Institution of Civil Engineers Design and Practice Guide: *Contaminated land: Investigation, assessment and remediation*
— Environment Agency 1999: *Methodology for the derivation of remedial targets for soil and groundwater to protect water resources*. R&D publication 20
— DETR, EA and Institute for Environment and Health 2000: *Guidelines for environmental risk assessment and management*. TSO
— CIRIA SP101-112: *Remedial treatment for contaminated land*
— CIRIA SP111: Volume XI: *Planning and management in remedial treatment for contaminated land*
— DETR CLR reports (see Annex D)
— DETR CLR 11: *Model procedures for the management of contaminated land* introduction and overview

Site operators/owners may also wish to use other guidance material e.g. Confederation of British Industry *Tackling contamination*, and also DETR's CLR 12: *Quality assurance in contaminated land consultancy*, to assist with the process of appointing appropriate specialists to assist them.

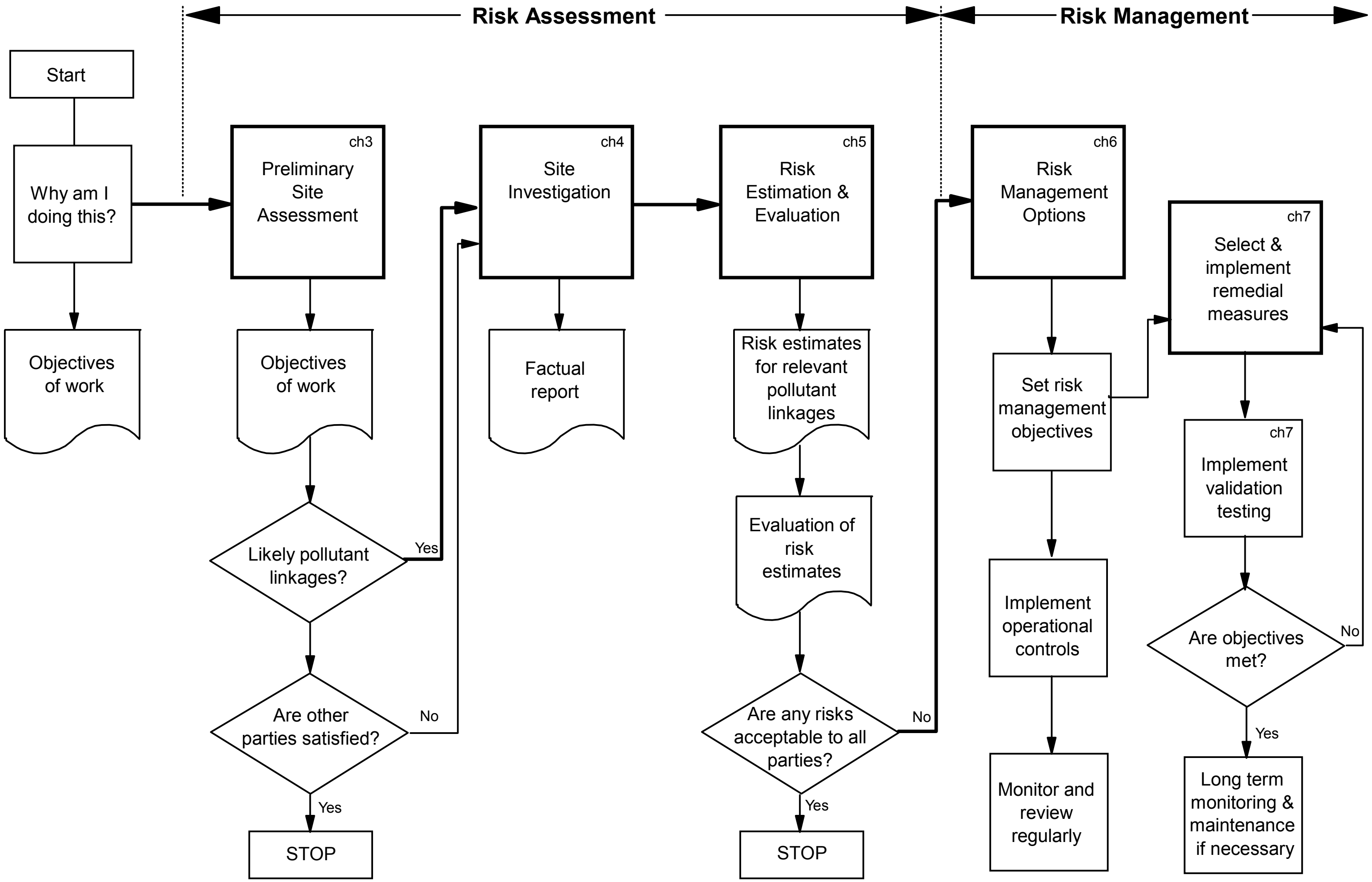

Figure 8 – Main steps involved in managing contaminated land

10.4 SITE INVESTIGATION

Where an operator is responsible for more than one site it is recommended that sites be ranked according to their pollution potential. The following factors may be considered to assist in this process:

— any leaks and spills recorded by the Local Authority or the owner;
— presence of single-skin abandoned tanks, which may be indicative of leaks;
— multiple abandoned tank farms indicating redevelopment;
— age of site as a fuel storage location.

None of the above factors should be used in isolation and it should be recognised that some sites over 50 years old may have no significant contamination upon investigation.

It should not be necessary to investigate petrol filling stations using intrusive techniques, such as drilling boreholes, in normal operational circumstances. Intrusive surveys will only usually be required:

— where a station is suspected of causing pollution e.g. oil in a stream, fuel smells in adjacent building, groundwater pollution;
— by planning authorities as part of redevelopment proposals;
— when buying or leasing an existing station.

No work should take place until the Local Authority and the Environment Agency have been informed (in the UK) and the location of buried services established.

An initial ERA should be carried out before any non emergency intrusive survey and should include:

— site history;
— construction and equipment type;
— hydrogeology;
— surrounding environmental receptors.

Investigation encompasses:

— all of the above, plus;
— shallow soil vapour survey at ~40 points across a service station;
— wells constructed to sample deeper soil and groundwater;
— analysis of samples for a wide variety of hydrocarbons and fuel additives.

Soil Vapour Survey (SVS) advantages:

— cheapest form of intrusive survey (~£500);
— quick, can be completed within eight hours;
— wide site coverage;
— good for locating plumes from line leaks;
— minimal disruption to the site.

Soil Vapour Survey (SVS) disadvantages:

— visual impact on tarmac or block pavement through the drilling of 40 small 10 mm diameter holes;
— little information below 1 m depth;
— no information obtained on groundwater depth or quality.

To obtain more detailed information groundwater wells are required. Generally 50-100 mm diameter they should be installed after a SVS to ensure optimum positioning in terms of contamination location. Wells should be completed with a lockable cover that clearly identifies it as a well and marked “NOT FOR FUEL”. In traffic areas the well cap should be sufficient to withstand a 44 t tanker.

For routine investigations a well will rarely need to be greater than 6 m deep and a minimum of three wells is usually sufficient to provide an appropriate level of information for any given petrol filling station. It should be noted that drilling companies typically charge by the day hence the cost of three wells is unlikely to be significantly greater than only one or two. Where significant contamination is found, a more extensive investigation will be required (see Section 12 on Emergency Spill Response).

10.5 SITE REMEDIATION

Remediation works may be carried out following substantial leaks or as required by a Planning Consent, Local Authorities, or prior to sale of the site for redevelopment. The scope of the works should be discussed with the appropriate enforcing agency and in many circumstances will require separate licensing or agreement:

— Local Authority approval for works on operational sites.
— Local Authority approval for works associated with redevelopment.
— Environment Agency approval for remediation activity that may fall within the waste management licensing or pollution prevention and control

regimes, which require permits under the Water Resources Act 1991.
— Emergency works to protect life or property do not require formal licensing.

Where remediation systems require discharges of treated effluent, a separate discharge consent may be required. Should the works require temporary storage of recovered free product, Local Authority consent will be required, even if the site has ceased to store petroleum spirit on a commercial basis.

A wide variety of remediation techniques exist and new technologies are in continual development. The principal methods used on petrol filling stations are briefly summarised in this section with their typical operating criteria. Remedial techniques fall into two categories: engineering and process based. A more comprehensive review of remedial techniques can be found in CIRIA Report 186, 1998.

All types of remediation should be carried out by experienced personnel and subject to detailed risk assessment and method statements. In the UK, works may also be subject to the Construction Design and Management Regulations where demolition is included in the scope of works.

10.5.1 Monitored natural attenuation (MNA)

It is now widely recognised that hydrocarbon contamination of soil and especially groundwater can attenuate naturally at a site under the right conditions. The principal mechanism is biodegradation. Naturally occurring microorganisms which use the hydrocarbon contamination as a food source break it down to the harmless products carbon dioxide and water. Natural attenuation is not a rapid process and can take several years, but monitoring the process to demonstrate that it is taking place at a sufficient rate to mitigate any risks can be a very cost effective alternative to expensive engineered solutions.

Further information and guidance on MNA can be obtained in Environment Agency publications *Natural attenuation of petroleum hydrocarbons and chlorinated solvents in groundwater* R&D Technical Report P305, prepared by Golder Associates (1999) and *Guidance on the assessment and monitoring of natural attenuation of contaminants in groundwater* R&D publication 95, prepared by Enviros Aspinwall and LGC (2000), and at the website howtomna.com.

10.5.2 Excavation and disposal

Petrol filling stations rarely cover more than 0,25 ha, making excavation and disposal of contaminated spoil often impractical, except during site redevelopment or closure. Where the opportunity to excavate spoil does exist, care should be taken to ensure adequate support to site boundaries and excavation sides. Excavation to solely remove contamination is not recommended in loose sand or gravel strata due to the risk of collapse. Alternative *in situ* technology is usually more suitable in such ground conditions.

It should be noted that disposal of arisings may be subject to Landfill Tax, although exemptions may be available where the site has been decommissioned and a redevelopment is proposed.

10.5.3 Vacuum extraction

In situ soil vapour extraction (SVE which may also be referred to as vacuum extraction, *in situ* volatilisation or soil venting) is effective in the removal of volatile compounds such as petrol from the unsaturated (above the water table) zone (CIRIA, 1998). The technique has the advantage of easy installation on an operational filling station and relatively low cost when compared to excavation. The technique uses a central vacuum pump to draw contaminants out of the ground, either for storage, destruction or other surface treatment. The vacuum pump may be configured to draw contaminated vapour (soil vapour extraction), free phase oils, groundwater, or a mixture of air and liquids (dual phase extraction).

Vacuum extraction techniques work best in loose sand and gravel although effective recovery can be gained in less permeable soils provided the extraction points are placed closer together and the treatment time extended. An impermeable surface such as clay or pavement is also usually required to maximise the zone of influence of an extraction well and avoid short-circuiting of the airflow. Due to the inherent variability of ground conditions a detailed site investigation, usually including pilot testing, is recommended before such techniques are used.

Vacuum extraction systems typically run for six to twelve months depending upon the level of existing contamination and the cleanup required. Where used as a means of boundary containment, a vacuum extraction trench may be operational for two to three years. This is because the trench is used to intercept migrating contaminants as opposed to reduction of the contamination in the source area.

10.5.4 Sparging

This technique involves the injection of compressed air below the water table. It is often used in combination with SVE. The compressed air drives volatile petroleum based contaminants from the soil and groundwater. The addition of oxygen at depth also assists in the acceleration of natural biodegradation. The air-vapour mixture is intercepted by SVE wells or collection trenches.

Sparging is a suitable technique for sand and gravel material, particularly those contaminated with petroleum rather than diesel. The technique is capable of achieving a high degree of contaminant removal from groundwater and can be used as combined soil and groundwater clean-up approach. However, sparging should not be used where a substantial quantity of free phase fuel is present, as more efficient techniques are available e.g. vacuum extraction. Where sparging is used, care should be taken to ensure that product is not forced offsite by the air injection. Where this risk exists, either the free phase should be removed first or a boundary collection system should be installed. This may be a line of closely spaced extraction boreholes or a recovery trench.

10.5.5 Free product recovery

Where large quantities of fuel are present, direct pumped recovery using well pumps may be suitable. The pumps can be configured to selectively pump free oil from above the water table and into storage. The technique generates little additional water but the zone of influence for each pump may not be great.

Table 7 – Typical engineering methods (see CIRIA SP104)

Method	Examples	Application	Limitations
Excavation	followed by: - off-site disposal - on-site disposal - clean-up treatment	- widespread - not contaminant or media dependent, although certain types of fill may be very difficult to excavate without major support measures	- does not treat the contaminants - can be costly and have practical difficulties - lack of, or limitations of, local licensed disposal sites - environmental concerns
Containment	- surface covering systems - vertical barriers - horizontal barriers - macro-encapsulation	- wide range of contaminants, especially complex mixtures - all media types - large or small sites	- requires careful design and implementation - susceptible to failure or damage - long-term durability unproven
Hydraulic control measures	- isolation/containment of contaminant plume - pumping for treatment purposes - in conjunction with containment measures	- all aspects of control and management of the hydrological regime - usually a temporary or short-term measure - most contaminants in water soluble form - especially useful for operational sites	- highly site-specific specialist design - long-term input needed - long-term monitoring - limited applicability to certain hydro-geological conditions

Table 8 – Typical process-based methods (see CIRIA SP104)

Process	Method	Examples	Application	Limitations
Thermal	- use of heat to remove or destroy contaminants	- thermal desorption - incineration - vitrification	- most soils* - mainly organic contaminants	- toxic emissions or residues possible - approvals needed for mobile plant - energy intensive
Physical	- separation - isolation or concentration of contaminants	- soil washing - solvent extraction - soil vapour extraction	- usually at early stage in the clean-up process - most contaminants	- do not destroy contaminants - difficult in clays - not a complete solution
Chemical	- use of chemical reactions to destroy or modify contaminants	- oxidation/ reduction - dechlorination - pH adjustment - hydrolysis extraction	- reasonably well established for liquids and slurries, some experience for soils, can be designed for the specific chemical conditions	- uncertainties over chemical reactions - limited experience in practice
Biological	- use of natural activities of micro-organisms to transform or destroy contaminants	- engineered treatment beds - reactor systems - land-farming - composting - ioventing	- organic contaminants - most soil types and water - operational sites	- very site- specific - difficult to predict precise timescale needed for effectiveness - not applicable to all contaminants
Solidification or Stabilisation	- immobilisation of contaminants	- inorganic binders e.g. cement, lime, organic binders	- proven for some inorganic contaminants, tests underway for organics - potentially suitable for wide range of media types	- needs long-term monitoring - containment rather than destruction

* Soil type may affect performance

11

CONTRACTOR ACCREDITATION AND ASSESSMENT OF CAPABILITIES

Operators should satisfy themselves that any forecourt contractors that are employed to undertake work on the forecourt are aware of the guidance contained in this publication and are familiar with the safety guidance contained in IP *Code of safe practice for contractors working on petrol filing stations*. Useful background information on the selection and management of contractors can be found in IP *Code of safe practice for retailers managing contractors working on petrol filling stations*.

A variety of accreditation schemes are available for contractors. Operators should ensure, as far as reasonably practical, that chosen contractors are competent. Where accreditation is not available then references should be sought from other companies or trade associations. For major development falling under the Construction, Design & Management Regulations, the selection and appointment of competent contractors is a legal requirement of the Designer.

Where a variety of contractors are present on site at any one time, the client should appoint a Principal Contractor (PC) in writing. The PC should be liable in contract for the safety performance of all other contractors and sub-contractors.

12

EMERGENCY SPILL PROCEDURES

12.1 LARGE SCALE INCIDENT RESPONSE PLAN

All sites storing fuel of any type should have an incident response plan. Site operators should consider the risks, consequences and emergency actions that may occur or be required following:

— spills during delivery of fuel;
— spills during dispensing;
— underground leaks.

The spill response plan should consider the immediate safety and environmental risks and consequences of a spill including the risk to off-site building and environmental targets such as watercourses and farmland. The plan should include details of:

— emergency procedures;
— contact numbers for notification and additional help;
— clean-up equipment;
— the layout of the site with services adjacent to the site clearly marked.

The plan should be reviewed annually to ensure it is up to date and should be communicated to all staff. Operators should ensure that all staff are appropriately trained.

Guidance can be found in UK Environment Agencies Pollution Prevention Guideline 21 *Pollution incident response planning*. This section is intended to give guidance to the owner or operator of a petrol filling station to develop an appropriate environmental response plan for a large leak or spill.

Site operators should be aware that in the event of a large leak or spill, the primary consideration is the health and safety of personnel, both on site and in the vicinity of the petrol filling station.

However, action to reduce the risk to health and safety is also likely to assist in the protection of soil, groundwater and surface waters, and air quality to a lesser extent. For guidance on non-emergency remediation see Section 10.

The aims of the emergency response are to:
— protect the public and employees;
— prevent migration off site and commence recovery/cleanup;
— establish the rate and direction of product movement.

A checklist at the end of this section summarises the key actions to be taken in an emergency.

12.2 FACTORS TO BE CONSIDERED IN THE RESPONSE PLAN

12.2.1 Identification of a large spill

If the final chamber of the oil/water separator, or the constructed wetland, shows any evidence of product following a known spill of any size:

1. Close the outlet valve, if there is one.
2. Close the site and shut down the forecourt electrics.
3. Call the fire brigade.
4. Contact the site owner, Local Authority, Environment Agency and an oil spill contractor.

12.2.2 Surface spills

— Uplift product from leaking tanks remembering that a spirit uplift will require a separate pump unit. Once emptied, tanks should be water filled by the fire brigade. During the uplift operation the whole forecourt should be a restricted area.
— Holed lines and all site electrics should be isolated.
— Any surface spill contained in an oil/water separator can be collected for disposal by vacuum tanker. Ensure vacuum trucks are always earthed.

It is possible for spills to migrate into the ground through cracks in the pavement and drains, expansion joints in the slab or via the drainage system. In such cases the considerations outlined for underground leaks in 12.2.3 will also apply.

12.2.3 Underground leaks

All spills will migrate off site down slope. If the product enters a duct or sewer the rate of movement may be greater than 500 metres per day. If the product is dissolved in groundwater the rate of movement can vary between millimetres and tens of metres per day. The level of risk and the extent of remedial action required will be determined by the rate of product movement.

In many cases the gradient of the site and the surrounding streets will give an indication of the route off site but note groundwater movement may not necessarily follow surface gradient.

Note: Petrol may seep through polythene water supply pipes and taint drinking water.

If there is any doubt as to the route of the drainage, plans of the sewers, telecommunications ducts etc. should be sought from the Local Authority, Environment Agency or water company. **In an emergency situation the fire brigade or police should obtain such plans**. The emergency services can obtain plans much faster than the other parties involved.

1. Check all drains, manholes, stopcock covers, cable ducts and floor voids on the site with a gas detector.
2. Working away from the site, concentrating on the down-slope direction, check all of the above in surrounding streets, plus any external gas or electric meter cupboards on houses, any cellars or under-floor voids.
3. If it is necessary to enter occupied premises, this is best done while accompanied by a police officer, at least for the first visit.
4. If there is good reason to enter an unoccupied building, especially commercial buildings at night, the fire brigade/police should contact the key holder.
5. Where product is found near an unoccupied building it will be necessary to enter, by force if necessary. In the UK this should be undertaken by the fire brigade/police who have statutory powers to enter.
6. Remember that in an incident the public cannot be relied upon to report smells accurately. They may not have a sense of smell or may mistake natural gas or damp for fuel. A decision to reoccupy should be made in conjunction with the fire brigade and Environmental Health Officer.
7. Repeat the checks at least every four hours until the flow direction is known. If heavy rain is forecast then the product could appear in drains or premises at short notice.

12.2.4 Product found off-site

1. Notify sewerage undertaker. Ventilate drains or ducts either by simply opening the covers or via mechanical means. Do not use compressed air blowers on ducts as the product can be forced into buildings. Extraction fans should be used and can often be hired locally.
2. Blowers may be used directly into affected buildings and cellars.
3. Notify sewerage undertaker. Sewers may be flushed with water by the fire brigade or Local Authority. However where sewer flushing is used it must be recognised that it may displace vapours. Downstream premises should be monitored closely.
4. Any building that has reported vapours should be evacuated, ventilated, and inspected for the route of entry. This is typically through wooden floors, drains or cable/gas ducts. Forced ventilation equipment can be sited outside an affected building and therefore need not be intrinsically safe. Extraction equipment used in drains or areas affected by high levels of vapour (>1%LEL) should be intrinsically safe.

The following tasks should be carried out on the station:

1. Carry out a line trace.
2. Carry out a soil vapour survey (SVS) as soon as possible.
3. Order appropriate boundary fencing and appropriate plant equipment such as concrete coring machine, drill rig, mechanical excavator, 8 yard skip (with lid to prevent rainwater entry), an earthworks lorry, six empty 200 litre lidded drums to site.
4. A 40 KVA generator should be put on standby.

Mobilise plant as soon as possible. The plant moves slowly and delays may be exacerbated by roadblocks associated with a major incident. If delays are anticipated the police will usually arrange, on request, an escort for plant.

Once the line trace is complete, the source of the leak is known, and the Environment Agency has been consulted, a borehole should be drilled as close to the leak site as possible. If the borehole encounters any contaminated ground, complete the hole as a groundwater well. If the well subsequently accumulates product it can be pumped or bailed out and disposed of appropriately.

— Consider the need for pumps, separators, air treatment units and storage tanks.
— Consider appropriate power supplies.
— If the plume is localised in a part of the site with no pipes, ducts or canopy it may be possible to dig out the source area of the plume. The excavation will emit high levels of vapours, requiring continuous gas detection. Work should be suspended if >10 % LEL is detected at the edge of the excavation, or 20 % LEL at the base of the cut. Spark arrestors and Chalwyn-type valves are normally required for this type of excavation, however in an emergency they may not be available. If excavations are required quickly, to prevent off-site migration, work should not be delayed by waiting for plant equipped with arrestors and valves. In such cases continuous gas monitoring should be carried out in and around mechanical plant. More harm and greater risk may be caused by delay.
— If product is found in watercourses or ditches they should be dammed with absorbent booms. Consider over-pumping contaminated water to a holding tank. The same approach can be applied to affected sewers. Wherever pumps and fans are used overnight it is important to consider their security from theft and malicious damage, including them being turning off, and their need for fuel.
— Waste excavation material, absorbents and liquid products may need temporary storage on site. This should be secure, covered storage that is held on site for no longer than absolutely necessary. Waste storage normally requires licensing or exemptions, however in an emergency the pollution control regulations provide a defence for emergency storage.
— Drill further holes on the site, down-slope of the leak and along the boundary where the plume is thought to leave site. It may be necessary to drill off site depending on where the plume is found. Once found, extraction can commence at the source, at the boundary, and even close to affected premises.

If the rate of recharge of product into the wells is low it may only be practicable to bail the wells by hand and store the product in drums for immediate disposal, or install a cut-off trench to capture migrating product. In general slow and steady pumped recovery from cut-off trenches or wells is preferable to excavation (where there is a high water table), unless the leak is confined to a small area and swift excavation can eliminate the source of the plume (more effective where there is a lower water table).

Large Spill Response Guidelines Checklist

1	If spill on site, **shut off dispensers, turn off forecourt electrics, evacuate site, call fire brigade**.
2	If spill is visible it should be contained with sand, and the oil/water separator closed.
	— Call site owner, Petroleum Officer, Environment Agency[5] and Environmental Health Officer
3	Arrange fuel uplift if required.
4	Any spill contained by oil/water separator, or constructed wetland, should be collected for disposal by vacuum tanker.
	— Ensure vacuum trucks are always earthed
5	Establish where oil/water separators are draining to (e.g. soakaway, sewer).
6	If any doubt about drainage route, get plans from LA, EA or Water Utility via Emergency Services.
7	If high vapour readings, then ventilate manually, by opening, or mechanically.
8	Contractor to carry out line trace, SVS, order skips, drums, generators, excavators and earthwork lorries as required.
9	Checks to detect gas on site and surrounding streets and houses should be carried out regularly.
10	If product found in unoccupied building it may be necessary for police/fire brigade to enter by force.
11	Any building with vapours should be evacuated, inspected and ventilated as required. Decisions to re-enter should be agreed with fire brigade and EHO.
12	Keep repeating checks every four hours until plume is found.
13	When source of leak is known, consult Environment Agency and drill borehole as close to leak site as possible. If the borehole encounters any contaminated ground, complete the hole as a groundwater well.
14	As the well accumulates product, bale or pump out product.
15	If product in ditches or watercourses, dam them with booms in consultation with the EA.
16	Make sure that there is secure storage for all plant to prevent it being stolen or tampered with.
17	Waste excavation material, absorbents and liquid products may need temporary storage on site. This should be secure, covered storage that is held on site for no longer than absolutely necessary. Consultation with the EA should be made.
18	In consultation with the EA drill further holes on the site, down slope of the leak and along the boundary where the plume is thought to leave site.
19	Once the plume is found, extraction can commence at the source, at the boundary and even close to affected premises. If rate of recharge of product into wells is low it may only be practicable to bail the wells by hand, alternatively extract by pump from wells or trenches. If leak is confined to a small area with no pipes, ducts or canopy, swift excavation can eliminate the source of the plume.

[5] UK Environment Agencies: Pollution Incident Notification (0800 807060), Control Office for movement of Special Wastes (08457 00 11 66).

12.3 SMALL INCIDENTS

This section provides recommended procedures that should be followed by the Responsible Person at the petrol filling station when:

a) a customer spills a large amount of product at the dispenser on the forecourt;
b) a customer spills a small amount of product at the dispenser on the forecourt;
c) a customer's vehicle develops a fuel tank leak.

Appropriate action to reduce the risks to health and safety will, in many cases, also ensure that environmental receptors are also protected.

12.3.1 Customer spills large amount of product at the dispenser

1. Ensure the vehicle is evacuated.
2. Position fire extinguisher upwind of the hazard.
3. Clear the spillage.
4. Push the vehicle off the forecourt (do not start the engine) and ventilate.
5. Inform line manager, and ensure the Petroleum Officer is informed.

12.3.2 Customer spills small amount of product at the dispenser

1. Clear the spillage.
   Petrol: Small amounts are best swept over as large an area as possible, they will rapidly evaporate. Larger amounts should be washed into the oil/water separator.
   Diesel: Small amounts should be absorbed with sand and then shovelled away for safe disposal. Larger amounts should be washed into the oil/water separator. Detergents should not be used to clean spillages.
2. Push the vehicle off the forecourt (do not start the engine) and ventilate.
3. Inform line manager, and ensure the Petroleum Officer is informed.

12.3.3 Vehicle develops a fuel tank leak

1. Push the vehicle off the forecourt (do not start the engine).
2. Deal with the spillage as above and ventilate the vehicle, including the boot.
3. Allow the customer to telephone for assistance in removing the vehicle.

ANNEX A
MODEL SCHEDULE OF INSPECTIONS AND TESTS

FORECOURT			
Tank tops empty of water			
Tanks with caps, locks and grade labels			
Offset fills with caps, locks and grade labels			
Vapour recovery with caps, locks and warning signs			
Oil/water separators clean and free from debris			
DISPENSERS			
Panels free of leaks and W&M seals in good condition			
Waste disposal area is clean and regularly cleared			
Fire extinguishers and sand buckets present at each dispenser island			
All public warning and information labels are posted			
Car wash area is clean and free of hazards			
Tank vents free of debris			
No audible noise from vent valves during delivery			
GENERAL AREAS			
Emergency doors free from obstruction and open outwards			
Emergency stop button working			
PA in working condition			
Electrical cupboard free of combustibles and locked			
Fire action notice displayed and complete			
Assembly point sign displayed			
OFFICE AREA			
Petroleum licence available with plans (expiry date)			
DCD licence available			
Vapour recovery authorisation (expiry date)			
Electrical test available and current			
Air regulations folder F59 available and complete			
Petroleum filling station register up-to-date and complete			
Risk assessments complete and up-to-date			
EHS Policy Statement is prominently displayed			
Emergency telephone numbers are up-to-date and displayed			
Accident book available and used (review trends)			
RIDDOR forms and guidance book available			
First aid box complete and clean			
Good housekeeping standards are maintained			
All weekly checklist actions are completed as planned			
Vapour recovery maintenance log available			
Vapour recovery instructions available			
COMPLETED BY: (Signature)			

MODEL SCHEDULE OF INSPECTIONS AND TESTS (Continued)

Dispenser Islands	
Visually check dispenser housings internally for fuel	
Check hoses for kinks and damage	
Check nozzle cut-off device is working	
Individual dispenser isolation switches are working	
Pipework & Vent Pipes	
Remove any shrubs around vent pipes etc. within a 3 metre radius	
Check all pipes are adequately labelled	
Check the condition of pipes and valves for signs of leaks, corrosion or damage	
Storage Tanks & Fill Points	
Check tanks for water build up	
Check tank top manholes free from water, product and are adequately labelled	
Check tank fill pipes are locked	
Check below ground offset fill point chambers are free from product, debris and labelled adequately	
Check manhole covers are seated correctly and can easily be lifted using appropriate lifting device	
Lighting Levels	
Check lighting levels are adequate in all areas, tankfarm, forecourt, office and shop	
Fire Fighting Equipment & Emergency Equipment	
Check that all fire extinguishers are present, fully charged and the correct number are present with no signs of damage	
Check sand buckets are full of dry sand and test fire alarms are working	
Check emergency switches (panic button) and loudspeaker system are functioning properly	
Check contents of first aid box are all present and correct	
Warning / Advice Notices	
Check all notices are posted as required, are undamaged, clean and legible	
Oil/Water Separator	
Check all chambers for the presence of petrol / oil and build up of grit and debris.	
Check drains are not blocked or full	
COMPLETED BY: (Signature) Date	

ANNEX B
MODEL SAFETY, HEALTH AND ENVIRONMENTAL POLICY

XXXX Petroleum Retail Company and its employees are fully committed to health, safety and environmental protection and will:

COMPLY with all relevant laws and regulations.

DESIGN, CONSTRUCT, OPERATE, MAINTAIN and **DISPOSE** of our assets in a healthy, safe and environmentally sound manner.

STRIVE for high standards of personnel health, safety and protection.

REQUIRE contractors to operate to the same high standard.

RESPOND quickly and effectively should any incidents occur.

TRAIN and encourage all employees to perform their jobs consistent with this policy.

MAINTAIN an excellent reputation in these fields.

Signed:____

Owner / Managing Director

ANNEX C
GLOSSARY

For the purpose of these guidelines, the following interpretations apply irrespective of any other meaning the words may have in other connections.

absorb/absorption (of gases): the taking up of gases into the inner structure of liquid.

adsorb/adsorption (of gases): the taking up of gases onto the surface of a material.

ACV (angle check valve): an underpump in-line valve to ensure product drains back to the tank in the event of a leak.

additive: detergent – performance enhancing additive that *inter alia* prevents coking of engines, improves combustion.

anti-static: conductivity improver.

arc: flow of electrical current at the instant of separation of two points e.g. break of an electrical contact.

auxiliary fuel: additional gas added to a vapour line feeding an incinerator to ensure that the hydrocarbon concentration of the vapour in the line is well in excess of the upper flammable limit (UFL).

bottom loading: the filling of a mobile container by means of a connection at ground level.
Typically 4"/ 0.101 m diameter.

breather valve: a valve designed to relieve the pressure or vacuum in a tank due to ambient temperature/pressure effects or vaporisation/ condensation of product.

breathing: emissions from, or intake of air into, a tank due to ambient temperature/pressure effects, or due to vaporisation/condensation of product.

bund: an enclosure bounded by a wall or by natural or constructed ground contours and designed to confine a spillage of product.

catalytic incinerator: an incinerator incorporating a catalyst designed to promote the oxidation of pollutants.

closed system: a product handling and transfer system designed to prevent vapours venting to atmosphere.

coaming: a structural device (often hollow) on the top of a road tanker to prevent damage to the tanker fittings in the event of a roll-over, sometimes utilised as a means of passing vapour from compartments to a common vapour collection point.

condensate: liquid formed due to the change of state from vapour to liquid.

containment: a means to prevent loss of liquid product in the event of a leak/spillage.

direct fill point: a product entry point, e.g. on an underground tank at a gasoline retail site, positioned directly on top of the tank.

distillate: generic term from middle boiling point distillate for a class of hydrocarbon products that include diesel and kerosene.

drop pipe: a fill pipe fitted vertically inside a tank and reaching the bottom of the tank, designed to reduce splashing during tank filling.
Typically 3" / 0.076 m diameter.

dry break coupling: a coupling designed to minimise the leakage of product when disconnected.

eductor: a device for increasing the flow rate of a vapour by decreasing downstream pressure.

emission: a release of product to the environment.

enrichment: the addition of a flammable gas, typically LPG, to a vapour line to ensure that the vapour concentration in the line is significantly greater than the upper flammable limit (UFL).

evaporation: conversion of a liquid to a vapour, without necessarily reaching the boiling point.

external floating roof: a device that floats on the surface of the product in an open top vertical tank.

fail-safe (valve): a valve that upon the removal of its activating force assumes a safe position.

fail-shut (valve): a valve that upon the removal of its activating force assumes a shut position.

faucet: a valve, in the context of mobile containers the valve at the end of the discharge/loading pipe.

fire engulfment valve: a valve designed to relieve at a sufficient rate to prevent the pressure in a vessel exceeding the design value when the vessel is subject to the temperatures expected during engulfment in a petroleum product fire.

fill pipe: a pipe either fitted to a tank or inserted into a tank to permit filling.

flash point: temperature at which a liquid gives off sufficient vapour to form an ignitable mixture with air near the surface of the liquid under standard test conditions.

flammable: (synonymous with INFLAMMABLE) refers to any substance, solid, liquid, gas or vapour, that is easily ignited.

flammable limits (or range): the limits of combustibility of flammable gases or vapours when mixed with air (*see upper flammable limit and lower flammable limit*) (Note: synonymous with EXPLOSIVE LIMITS or RANGE).

flow rate: litres per minute or gallons per minute (lpm/gpm) 1000 lpm = 220gpm.

foot valve: a valve at the base of a mobile container.

fuel grades:

Four Star – Leaded fuel
Kerosene / Paraffin
PUL/EM13 – Premium
Unleaded 95-97 RON SUL/EM38 – Super Unleaded
ULSD/EG15 – Ultra Low sulphur diesel
Gas Oil – EG9
Burning Oil – EK3

gauging device (level): a device for the measurement of the level of liquid in a tank.

hazardous area: an area in which there exists or may exist an atmosphere containing flammable gas or vapour in a concentration capable of ignition.

hazard and operability study (HazOp study): a study taking account of all foreseeable normal and abnormal circumstances that could lead to hazardous situations in and around a piece of equipment.

high level cut-off (HLCO) system: a safety system that stops the flow of liquid into a tank to ensure that it is not overfilled.

hydrocarbon: a compound made up entirely of hydrogen and carbon atoms.

ignition source: accessible source of heat or energy, electrical or non-electrical, capable of igniting flammable atmospheres.

inert gas: a gas or mixture of gases which will not support combustion.

inerting: the addition of inert gas to a vapour line or vessel to ensure that the oxygen concentration of the vapour in the line or vessel is significantly less than that required to sustain combustion of the vapour.

interlock: a safety system that ensures that two or more actions can only take place in a pre-determined sequence.

incendive spark: of sufficient temperature and energy to ignite a flammable substance.

lance loading device: a fixed location fill pipe which can be mechanically inserted into a mobile container.

lower flammable limit (LFL): the lowest concentration of flammable gas in air at atmospheric pressure capable of being ignited, expressed as percentage by volume.

liquid: flammable (flash point <55°C).

LEL/UEL: lower and upper explosive limits. The Oxygen : Fuel concentration in % range necessary to support combustion.

mobile container: a tank in which liquid product can be transported, e.g. a road tanker, rail tank car, barge or sea-going tanker.

off-set fill point: a filling point, e.g. on a service station tank, on which connection for the hose of the delivery vehicle is at some distance from the tank.

orifice plate: a device to restrict the flow through a pipe to a pre-determined extent.

overfill prevention device (OPD): see high level cut-off system.

permeate (of a membrane): in a membrane gas separation system, that part of the vapour which passes through the membrane.

poppet valve: a valve mounted in half a coupling that is opened by a protruding member on the other mating half of the coupling.

pressure relief valve: a valve which automatically prevents excessive pressure in the tank or pipe to which it is connected.

pressure/vacuum valve (P/V valve): a dual purpose valve which automatically prevents excessive positive or negative pressure in the tank or pipe to which it is connected.

RTW: road tank wagon. A tanker usually rated between 18 – 44 tonnes.

saturated vapour: a hydrocarbon vapour/air mixture which can not contain any further hydrocarbons at specified pressure and temperature.

secondary seal: a seal mounted above a primary seal to increase the vapour retention efficiency.

self-checking (device): a device that automatically checks whether a fault exists within it.

self-sealing (device): a device that automatically shuts when the force keeping the device open is removed.

shell (of tank): the walls of a tank.

single stage (vapour recovery unit): a vapour recovery unit in which the reduction in vapour concentration from inlet to vent is undertaken in one process step.

splash loading: filling of a tank resulting in excessive splashing and vapour generation.

Stage 1a: the control of vapour emissions during gasoline storage and loading at a refinery or terminal.

Stage 1b: the control of vapour emissions during the filling of a storage tank at a service station.

Stage 2: the control of vapour emissions during the filling of a fuel tank of a vehicle.

sump tank: tank installed in a vapour line at its lowest point to collect condensate or product accidentally introduced into the line.

switch loading: the practice of loading a less volatile product into a mobile container that has previously contained a more volatile product.

ullage: the free space above the liquid product in a tank.

upper flammable limit (UFL): the concentration of flammable gas in air at atmospheric pressure above which combustion will not occur, expressed as percentage by volume.

vapour balancing: a practice by which vapour displaced during the filling of a container by product is fed back to the ullage of the container from which the product was discharged.

vapour collection system: the pipework and associated equipment which are used to connect vapour emission sources to a vapour control unit.

vapour concentration: the percentage of hydrocarbons in a hydrocarbon/air mixture.

vapour control system: the combination of a vapour collection system and a vapour control unit.

vapour control unit: a device for the reduction in the hydrocarbon concentration in a hydrocarbon/air mixture. This can be achieved either by recovering the hydrocarbons in a vapour recovery unit or by destroying them, e.g. in an incinerator.

vapour generation: the production of hydrocarbon vapour by evaporation of a volatile product. Where this occurs during filling of a tank a greater volume of hydrocarbon/air mixture will be emitted than the volume of product pumped into the tank due to the vaporised hydrocarbons being added to the air existing in the tank before filling.

vapour header: the main vapour pipe feeding vapours to a vapour control unit. Pipes connected to individual emission sources are manifolded into this main pipe.

vapour holder: a variable volume tank designed to store vapour prior to processing in a vapour control unit.

vapour recovery unit (VRU): a device that separates hydrocarbons from air and converts them back to liquid.

volatile organic compound (VOC): compound containing at least one carbon atom and which in liquid form readily evaporates at ambient temperature. Not all VOCs are hydrocarbons: e.g. ethers are not hydrocarbons as they also contain oxygen atoms.

vapour pressure: the pressure exerted by a volatile liquid.

water bottom: water accumulated in the base of a storage tank.

weather shield: a device fitted above seals on external floating roofs to cover and hence protect the seals.

ANNEX D
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[7]Available from CBI, Centre Point, 103 New Oxford Street, London, WC1A 1DU, Tel +44(0)20 7395 8247, Fax: +44(0)20 7240 1578, www.cbi.org.uk

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