
APPENDIX 7

Guidance for the Design, Construction, Modification and Maintenance of Petrol Filling Stations

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FOREWORD

The safety of people and protection of the environment are major concerns at petrol filling stations. There is potential for accidents at all sites where petroleum fuels are stored and dispensed, and the risks are significantly increased at sites to which the general public has unrestricted access. The necessity for well designed and constructed facilities, properly operated and maintained, is of paramount importance. Petrol and other motor fuels are potentially hazardous; at ambient temperature, petrol gives off vapours which, when mixed with air in appropriate proportions, can burn with explosive force if ignited. In addition, all petroleum products are potential pollutants which, if released, can cause damage to the environment. They are injurious to aquatic life, and can have harmful health effects for humans if incorrectly handled.

This guidance has been prepared following an invitation from the Health and Safety Executive for industry to prepare a replacement for the technical content of *HS(G)41 Petrol filling stations: Construction and operation*. At the same time, the HSE adopted a risk based approach to safety at petrol filling stations, the principles of which are

set out in its guidance note *HS (G)146 Dispensing petrol: Assessing and controlling the risks of fire and explosion at sites where petrol is stored and dispensed as a fuel*. This new approach followed the publication in 1994 of the *Deregulation Task Forces Proposals for Reform* designed to reduce the burden of regulation on business.

This new technical guidance offers alternative means of dealing with varying levels of risk identified using the recommendations of HS(G)146. Various control measures and procedures representative of good practice are described with a view to minimizing the risks and providing a high level of safety and environmental protection. The guidance given is based on the results of experience, and provides users with comprehensive information on proven developments in the petroleum industry.

It must be recognised, however, that absolute safety is not possible. There is always some element of risk present; the aim must be a balance between the residual risks, safety, operational requirements, practicality and the cost of additional safety measures. There is generally a point beyond which increased safety measures add to the cost in undue proportion to the added protection they provide.

The guidance is not exhaustive but represents the best available information at the time of drafting. It is not intended to be prescriptive nor to preclude the use of new developments, innovative solutions or alternative designs, materials, methods and procedures, so long as such alternatives provide a level of control over safety, pollution or health hazards appropriate to the risks identified. Where the word "should" is used, this describes good practice and is therefore a recommendation; where "must" is used it refers to a legal requirement and is therefore mandatory.

This publication was produced in consultation with the Health and Safety Executive.

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SCOPE

This guidance considers the technical aspects of the planning, design, construction, commissioning,

and electrical installation of both new and refurbished sites. In addition to the advice on maintenance procedures, comprehensive guidance is given on inspection and testing of the electrical installation at new and refurbished sites prior to commissioning as well as subsequent inspection and testing at operating sites.

Technical guidance is provided for the storage and dispensing of petroleum products used as fuels for motor vehicles including petrol and diesel fuel and some limited aspects of liquefied petroleum gas (LPG); compressed natural gas (CNG) is not covered. Whilst not specifically written for installations such as marinas to which the public may have access, nor non-retail facilities such as commercial vehicle depots, farms, etc., the principles are equally applicable to such installations. The document describes good practice and is aimed at:

- those involved in planning, design, construction or alteration of such installations;
- alteration, maintenance and decommissioning of petrol-
- those involved in maintenance of such installations

filling stations. It covers civil, mechanical, hydraulic installations;

- minimizing the risks from fire and explosion;
- minimizing the risks to health and the environment.

In addition it will be of interest to those involved in regulating the operation of petrol filling stations as well as those whose function it is to operate them.

In special cases, such as unattended sites or semi permanent installations, alternative safety measures and procedures to deal with the specific risks identified may need to be adopted to achieve the same level of protection as that afforded by the guidance given in this document.

The design, construction and installation details for controlling identified hazards are described but operational procedures are outside the scope of this document as is the procedure for the assessment of risk.

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RISK ASSESSMENT

2.1 GENERAL

The assessment and control of risks at a petrol station make good business sense but they are also a legal requirement under the Health and Safety at Work Act 1974 and other related legislation. In particular the Management of Health and Safety at Work Regulations 1992 requires employers and the self employed to assess the risks to workers and others (including the general public) who may be affected by their undertaking, so that they can decide on what measures need to be taken to comply with health and safety law.

The control measures: described in this guidance are aimed at aiding this task of minimizing the risks associated with the storage and dispensing of petrol. Where possible a choice of control measures, which are all based on current good practice, are given to enable the most appropriate combination of measures to be selected to suit a particular facility or circumstance. The final choice of, or any variations from, the recommended control measures should be arrived at only after a careful assessment of the actual risks to people or the environment occurring at each particular facility.

2.2 FIRE PRECAUTIONS

A major concern associated with the storage and dispensing of petrol is the risk of fire and explosion. The term 'fire precautions' is used to describe the

controls that are necessary both to prevent a fire or explosion occurring and also to safeguard those present should a fire occur. These different but related aspects are commonly referred to as Process Fire Precautions and General Fire Precautions.

It is important in carrying out the required risk assessments that both aspects are properly considered. That concerning process fire precautions should form part of the overall risk assessment for health and safety as required by the Management of Health and Safety at Work Regulations. That concerning general fire precautions may form part of that assessment or be pieced out separately.

2.2.1 Process fire precautions

These are the special precautions in any premises in connection with the carrying on of any work process, including the use and storage of any article, material or substance in connection with or directly from that process, which are designed to prevent or reduce the likelihood of fire breaking out or its intensity. They can more simply be considered as the precautions and the means of preventing the outbreak and rapid spread of fire due to work or manufacturing processes. Advice on assessing the risk of fire and explosion and means of minimizing this at places where petrol is stored and dispensed is contained in the HSE publication HS(G)

146 Dispensing petrol - Assessing and controlling the risks of fire and explosions at sites where petrol is stored and dispensed as a fuel. HS(G) 146 should be read in conjunction with this guidance.

2.2.2 General fire protection

In the event of outbreak of fire, adequate measures need to be in place to provide for the safety of those present (including the general public). This is a requirement of the Fire Precautions (Workplace) Regulations 1997 and the Fire Precautions Act 1971 and covers both buildings and outdoor areas, such as the forecourt, forming part of the facility or undertaking. These general fire precautions include the means for detecting fire and giving fire warning, the means for fire fighting, the means of escape and for ensuring escape routes can be used safely and effectively by employees and members of the public visiting the site, and the training of employees in fire safety.

Advice to aid employers (and the self employed) carry out their risk assessment for general fire precautions and put the necessary precautions in place is given in the document *Fire Safety - an employer's guide*, published jointly by HSE and the Home Departments (ie. Home Office, Scottish Executive and Northern Ireland Office).

2.3 ENVIRONMENTAL

Many of the recommended controls to prevent fires and explosions will also minimise damage to the environment. A separate assessment, however, should be made of the actual risks to the environment from spill or leaking fuel during normal use or that which might arise from equipment failure or operator error. These should include site specific circumstances such as the proximity of the installation to watercourses, and should have regard to the site geology in order that the risks from accidental spillage etc. can be identified. The historical use of the site should also be considered, since if the installation is built on the site of a former petrol filling station the presence of old or redundant tanks may give rise to contamination. The environmental assessment may indicate the need for measures in addition to those already identified to control the safety hazards. Advice on assessing environmental risks can be obtained from the Environment Agency in England and Wales and from the Scottish Environmental Protection Agency (SEPA) in Scotland, also from an IP publication in course of preparation (see references).

2.4 HEALTH

In addition to creating safety and environmental hazards, petrol can also pose a health hazard if it is inhaled, ingested or comes in contact with the skin or eyes. The risks from inhaling or contact with petrol should be considered in the assessment required under the Control of Substances Hazardous to Health Regulations 1999. Exposure to petrol should be controlled and taken into account in the planning and design of the site. The hazardous characteristics of petroleum and its potential for damage to health and the environment are described in Annex 2.1. Further advice can be found in the HSE Approved Code of Practice: *Control of substances hazardous to health*. Toxicity information on petrol is contained in product dossier no. 92/103 prepared by CONCAWE.

Particular consideration needs to be given to repair and maintenance activities, spillage clean-up and other operations which could result in frequent or high exposure to petrol vapour, liquid petrol or its residues.

2.5 REFERENCES

Control of Substances Hazardous to Health Regulations, 1999.

CONCAWE product dossier 92/103.

Environment Agency PPG 1: *General guide to the prevention of pollution of controlled waters*.

Environment Agency PPG7: *Fuelling stations: construction and operation*.

European Directive 94/63 EC - *Control of volatile organic compound (VOC) emissions resulting from the storage of petrol and its distribution from terminals to service stations*, 1994.

Fire Precautions Act, 1971.

Fire Precautions (Workplace) Regulations, 1997. Health and Safety at Work Act, 1974.

HSE/Home Department, *Fire Safety - an employer's guide*.

HSE: Approved Code of Practice *Control of substances hazardous to health*.

14SE: HS(G) 146: *Dispensing petrol – Assessing and controlling the risks of fire and explosion at sites where petrol is stored and dispensed as a fuel*.

Institute of Petroleum, *Guidance document of risk assessment for the water environment at operational fuel storage and dispensing facilities*. Due to be published late 1999.

Management of Health and Safety at Work Regulations, 1992.

ANNEX 2.1

HAZARDOUS CHARACTERISTICS OF PETROL

Petrol is a mixture of many organic substances and has properties that can give rise to fire, explosion, health and environmental hazards. These hazards can also arise if petrol is misused off site and for this reason it is important that petrol is only dispensed into properly designed and labelled containers.

A2.1.1 Typical properties

The actual properties of petrol can vary widely depending on its source, additives and product specification but typical physical properties are listed in the table below:

Property	Typical values
Boiling range	25 - 220 °C
Vapour pressure at 37.8°C	350 - 900 Kpa
Water solubility	30 - 100 mg/l
Flashpoint	less than -40 °C
Auto-ignition temperature	Greater than 250 °C
Lower explosion limit (LEL)	1.4% v/v
Upper explosion limit (UEL)	7.6% v/v
Density at 15 °C	0.72 - 0.79 g/ml
Vapour density (air equals 1.00) at 40 % saturation	1.7-2.0

A2.1.2 Fire and explosion hazards

Petrol is a volatile liquid and gives off vapour even at very low temperatures. The vapour, when mixed with air in certain proportions, can form a flammable atmosphere which burns or explodes when confined if a source of ignition is present. A flammable atmosphere exists when the proportion of vapour in the air is between approximately 1% (the lower explosion limit) and 8% (the upper explosion limit).

Petrol vapour is heavier than air and does not disperse easily in still air conditions. It tends to sink to the lowest level of its surroundings and may accumulate in tanks, cavities, drains, pits or other depressions. Accumulations of vapours in enclosed spaces or other poorly ventilated areas can persist for long periods even when there is no visible sign of the liquid. Petrol floats on the surface of water; it may therefore be carried long distances by water courses, sewers, ducts, drains or groundwater and create a hazard remote from its point of release.

Flammable atmospheres may be present in the vapour spaces of tanks containing petrol and in tanks after petrol has been removed. They may also exist where clothing and other absorbent material or substances are contaminated with petrol.

A2.1.3 Health hazards

Petrol can give rise to health problems following excessive skin contact, aspiration, ingestion or vapour inhalation and these should be considered in the assessment required under the Control of Substances Hazardous to Health Regulations 1999. Exposure to the liquid or vapour should be minimised and where possible this should be taken into account in the planning and design of a petrol filling station. During all work activities or operations where petrol or its vapour might be present effective controls and handling procedures should be implemented in accordance with the above Regulations.

Petrol is extremely volatile and can give rise to significant amounts of vapour at ambient temperatures. Petrol vapour, even when present in the atmosphere at levels below the lower explosive limit, can have acute and chronic effects if inhaled.

A2.1.3.1 Inhalation

Exposure to petrol vapours with a concentration of between 500 and 1000 ppm can cause irritation of the respiratory tract and, if continued, will cause a narcotic effect with symptoms including headaches, nausea, dizziness and mental confusion. Prolonged exposure will lead to loss of consciousness. Higher vapour concentrations can rapidly give rise to these effects on the central nervous system and cause sudden loss of consciousness even after only short exposure. Petrol vapour is heavier than air and can accumulate in confined spaces, pits, etc. to cause a health hazard from either the toxic effects or as a result of oxygen deficiency.

There are no reports of adverse health effects arising directly from normal motor refuelling and tanker unloading operations where the exposure is only to low concentrations of vapours for short and infrequent periods. Where exposure to petrol vapour is likely to be higher, in situations such as accidents or spills or where work is being carried out on the petrol containing plant it will be necessary to consider the potential toxic contamination or pollution will result: hazards as well as the fire hazards and to implement appropriate controls.

A2.1.3.2 Ingestion

Ingestion of petrol may irritate the digestive system and cause diarrhoea. Although petrol has only low to moderate oral toxicity for adults, ingestion of small quantities can be dangerous or even fatal to children. Ingestion of petrol is unlikely at a filling station but occurs as a result of siphoning from fuel tanks and, with children in particular, after drinking from incorrectly labelled and/or stored containers.

A2.1.3.3 Aspiration

Aspiration of petrol directly into the lungs may occur following vomiting after the ingestion of petrol. Aspiration of even small amounts of petrol can have serious consequences as it can rapidly lead to breathing difficulties or even potentially fatal chemical pneumonitis.

A2.1.3.4 Skin contact

The components of petrol are degreasing or de-fatting agents and repeated skin contact will result in drying and cracking of the skin and possibly dermatitis. Sensitisation to the dyes used in some products has been reported in a few cases. Repeated exposure to petrol may also make the skin more liable to irritation and penetration by other chemicals. Prolonged skin exposure to petrol, as might occur during an accident, has been reported to result in chemical type burns.

A2.1.3.5 Eye contact

Moderate to severe irritation and conjunctivitis may result if liquid petrol comes into contact with the eyes. The effect is normally transient and permanent injury is unlikely to occur. Extended exposure to high levels of petrol vapours may also cause irritation of the eye.

A2.1.4 Environmental hazards

Petrol is a complex mixture of up to 240 individual hydrocarbons most of which have varying degrees of toxicity towards living organisms and plants. If released at a filling station by spillage or leaks from tanks and pipes it may, in the absence of adequate controls, either soak into the ground directly or flow into drains or culverts. Its subsequent dispersion and movement will be difficult to predict and will depend on the geology of the area and the physico-chemical properties of the soil and rocks. In most cases some of the following types of

- petrol adsorbed onto soil particles or held in the soil pores;
- free petrol floating on the groundwater;
- petrol constituents dissolved in the groundwater;
- free petrol at impervious ground layers such as clay;
- petrol floating on surface water (i.e. rivers and lakes);
- petrol constituents dissolved in surface water;
- free petrol in drains (in use or redundant) or underground voids;
- petrol vapours released from the above sources into the atmosphere or underground voids etc.

A2.1.4.1 Vapour releases

Vapours released from petrol as a result of spills or leaks and more significantly during transfer operations 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. Concerns over the emissions of petrol vapour have led to the introduction of a European Directive 94/63/EC OJL 365 (31/12/94) that requires installation of controls to limit the release of petrol vapours during all tanker unloading at the majority of petrol filling stations.

A2.1.4.2 Petrol to soil

Petrol adsorbed into 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 air movement causing evaporation, the water solubility of the hydrocarbons, water movement, biodegradation, and soil absorption. The extent and duration of the pollution will also depend on the quantity and duration of the petrol release and any subsequent action. Small releases may disperse on their own according to the above processes but large or persistent releases may require expensive soil surveys and remedial action. Petrol has been reported to have contaminated drinking water supplies directly by migrating through polyethylene water pipelines in heavily contaminated ground.

A2.1.4.3 Petrol to groundwater

Of particular concern following release of petrol is contamination of groundwater, rivers or lakes especially in areas where potable water is extracted. Many of the components of petrol have a significant solubility in water and once dissolved their rate of biodegradation is much reduced. Component levels are then only significantly reduced by dilution and dispersion. As well as being toxic towards aquatic life, petrol will 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.

The discharge of petrol 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. The Environment Agency (SEPA in Scotland) is responsible for the protection of controlled waters from pollution and has issued several relevant guidance notes, for example PPG 1 *General guide to the prevention of pollution of controlled waters*, and PPG 7 *Fuelling stations construction and operation*.