BITUMEN SAFETY CODE

SAFETY, HEALTH AND ENVIRONMENTAL ASPECTS OF DESIGN, CONSTRUCTION, OPERATION, INSPECTION AND MAINTENANCE OF BITUMEN MANUFACTURE, BLENDING, STORAGE, DISTRIBUTION, PRODUCT HANDLING AND USE, AND SAMPLING

Model Code of Safe Practice in the Petroleum Industry
Part 11
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Model Code of Safe Practice in the Petroleum Industry
Part 11

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The tables are given by reference to a web page that is regularly updated rather than by being included in this Code because,
with the replacement of British Standards by harmonised European Standards, those details are changing.
FOREWORD

IP Bitumen safety code provides good health, safety and environmental protection practice, rather than a set of rigid rules, for the whole product life cycle of manufacture, blending, storage, distribution, handling, use and sampling.

The 4th edition of IP Bitumen safety code follows a comprehensive review of all sections; whilst amendments have been made throughout the Code, major changes have been made to:

— Account for the introduction of new bitumen specifications being developed in the European Committee for Standardisation (CEN) (Section 1) and to provide a means to better communicate those amendments and product handling and storage temperatures (see web page http://www.energyinst.org.uk/bitumen).
— Rationalise information on health research studies, but provide improved guidance on health management, in particular hazards, exposure mechanisms, generic inhalation exposure data, control measures and recovery strategies (Section 2).
— Account for the implications of the Dangerous Substances and Explosive Atmospheres Regulations (DSEAR), in particular, the control of flammable atmospheres, and the control of both electrical and non-electrical sources of ignition, and provide improved guidance on foreseeable fire scenarios (Section 3).
— Provide improved guidance on planning for fighting fires and definition of necessary response capabilities for small and large tank fires (Section 4).
— Provide new guidance on environmental protection, given its greater prominence (Section 5).
— Apply the updated philosophy for area classification to storage tanks (Section 8).
— Account for the need for better control of high level access (Section 9).
— Simplify health exposure data for product handling and use applications (Section 10).
— Enhance the guidance on the requirements for the safe delivery of bitumen products to customer sites (Section 10).
— Improve the guidance on product handling and use such as mobile heating kettle operations, product handling in roofing applications, and fluxed and cold mix asphalt manufacture and use (Section 10).
— Account for increased understanding of the flammability of petroleum products when in the form of a mist, spray or foam (Annex A).
— Account for the updated philosophy for area classification and the selection of suitably protected equipment for use in hazardous areas (Annex C).

IP Bitumen safety code should be drawn to the attention of those with responsibility for the design, construction, operation, inspection and maintenance of bitumen handling installations, both in the manufacturing, blending, storage and distribution sectors, but also in the user sector of the bitumen industry, where operations may be somewhat less controlled than is the case within the petroleum industry generally.

The Code is necessarily generalised, therefore those devising procedures for their operations should also take into account the effect of any unusual or local circumstances, on which it is impossible to generalise.

Whilst written in support of the UK regulatory framework, the IP Bitumen safety code should be similarly applicable in other countries providing national and local statutory requirements are complied with.

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The revised Code has been prepared under the auspices of the Energy Institute Safety Management Group and will be reviewed from time to time. It would be of considerable assistance in any future revision if users would send comments or suggestions for improvement to:

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Project co-ordination and technical editing was carried out by Mark Scanlon (Energy Institute).
INTRODUCTION

1.1 SCOPE AND APPLICABILITY

This Code covers health, safety and environmental protection in manufacture, blending, storage, distribution, handling and use and sampling of bitumen.

It applies generally to all grades of bitumen meeting internationally recognised specifications but, where guidance is grade-dependent, as in the case of storage temperature guidance, it refers to bitumens meeting the British Standard specifications referred to in 1.2.1 to 1.2.7. A similar range of gradings is found in other national specifications, but care is necessary to ensure that any other grade to which this particular guidance is applied is equivalent to the British Standard reference grade in all relevant respects. Furthermore, with the introduction of harmonised European standards, similar grades are being supplied throughout Europe.

The practice of adding coal tar to bitumen products has been decreasing such that it is not routinely used in road materials; it is used only rarely for specialised applications such as garage forecourts. Although often grouped with bitumen because of their past uses in similar applications, coal tars and pitches are very different in their chemical and toxicological characteristics and are not to be confused with bitumen either when used alone or when blended with bitumen. Therefore, coal tar is considered to be out of the scope of this Code. Guidance on safe handling of coal tar products should be contained in the supplier’s current Material safety data sheet (MSDS).

1.2 DEFINITION OF BITUMEN

Bitumen is defined by IP and in BS EN 12591 as a 'virtually involatile, adhesive and waterproofing material derived from crude petroleum, or present in natural asphalt, which is completely or nearly completely soluble in toluene, and very viscous or near solid at ambient temperatures'.

Bitumen is defined in a similar manner in most parts of the world outside North America. So that unnecessary confusion does not arise, it should be noted that in the UK the term asphalt is used for a mixture of bitumen and mineral matter such as stone, sand and filler. However, in the USA, the term asphalt or asphalt cement is applied to the product defined in most parts of the world as bitumen.

When natural seepages of bitumen are intruded by fine mineral matter, they are referred to as natural asphalts (asphalte).

The principal types of bitumen are referred to as paving (formerly penetration) grade, hard paving grade, oxidised grade, hard industrial grade and cutback bitumens, plus polymer-modified bitumens. In addition, bitumens may be formulated as emulsions.

1.2.1 Paving grade bitumens

Paving grade bitumens were previously known as penetration grade bitumens. These are produced as residual products from the distillation of petroleum, subjected in some cases as outlined in Section 6 to a
partial oxidation process.

British Standard grades (see Table 1.1 on web page http://www.energyinst.org.uk/bitumen1) are designated by two numbers separated by a forward slash representing the penetration range and the suffix 'pen' (e.g. 40/60 pen); a similar range is used in other national specifications. Soft paving grade bitumens are designated by the mid-point of the viscosity range at 60 °C preceded by the letter 'V'.

1.2.2 Hard paving grade bitumens

Some of the harder bitumens formerly known as penetration grade bitumens will be known as hard paving grade bitumens in the new European specifications (see Table 1.1 on web page http://www.energyinst.org.uk/bitumen1). These bitumens are used principally for road surfacing but also for industrial applications and roofing.

1.2.3 Hard industrial grade bitumens

These are produced in ways similar to those used for paving grade bitumens but they have lower penetration values and higher softening points. British Standard grades (see Table 1.2 on web page http://www.energyinst.org.uk/bitumen1) are designated by the prefix ‘H’ followed by two numbers representing the limits of the softening point range. These bitumens are used, for example, in paints and enamels. In the new European specifications the former BS hard grade bitumens prefixed by 'H' will be known as 'hard industrial grade' bitumens, and the grades used for paving applications will be known as 'hard paving grade' bitumens (see 1.2.2).

1.2.4 Oxidised grade bitumens

These are produced as described in Section 6 by passing air under controlled temperature conditions through soft bitumens admixed with a flux. They are more rubber-like than paving and hard grade bitumens. British Standard grades (see Table 1.3 on web page http://www.energyinst.org.uk/bitumen1) are designated by two numbers representing the mid-points of the softening point and penetration ranges in that order. These bitumens are used widely in the manufacture of reinforced bitumen membranes (RBMs) for roofing, waterproof papers and electrical goods.

1.2.5 Cutback bitumens

These are bitumens, the viscosities of which have been reduced by blending with low viscosity diluents such as kerosine (see Table 1.4 on web page http://www.energyinst.org.uk/bitumen1). These are designated by a number representing the mid-point of the standard tar viscometer (STV) viscosity range and the suffix 'secs'. These bitumens are used largely for road surfacing applications. Their blending process is described in Section 7.

Special cutback bitumens are used for producing mastics and aggregate mixes. Where other specifications employ diluents of different flash point to kerosine, such as naphtha or gas oils, this should be taken into consideration in their handling and hygiene precautions.

1.2.6 Polymer-modified bitumens

Polymer-modified bitumens usually consist of a paving grade bitumen into which a proportion of organic polymer has been mixed. The base bitumen may be a normal paving grade bitumen or one selected specifically for compatibility with the polymer. The polymers are added in order to enhance certain properties of the binder when the final product will not provide the required properties with unmodified bitumen. Many polymers have been used, including plastomers such as ethylene vinyl acetate (EVA) and elastomers such as styrene-butadiene-styrene (SBS) block copolymers. The common feature of the polymers is that at high temperatures they dissolve in the bitumen.

Polymer modifiers such as SBS and atactic polypropylene (APP) are also used to enhance the behaviour of RBMs for roofing.

Polymer-modified bitumens can be defined by the type and proportion of the polymer and/or by the properties of the polymer-modified bitumen. Types and grades typically in use are described in Table 1.5 on web page http://www.energyinst.org.uk/bitumen1.

1.2.7 Bitumen emulsions

Bitumen emulsions are dispersions of bitumen in water, achieved by the use of emulsification agent additives. They are used largely for road surfacing applications. Cationic and anionic types are produced and the grades typically in use in the UK are described in

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1The tables are given by reference to a web page that is regularly updated rather than by being included in this Code because, with the replacement of British Standards by harmonised European Standards, those details are changing.
INTRODUCTION

BS 434-1 and in Table 1.6 on web page http://www.energyinst.org.uk/bitumen¹. Bitumen emulsions are also made for industrial applications such as waterproofing and adhesives; there is no British Standard for these emulsions.

1.3 HAZARDS OF BITUMEN

When handling and using bitumens, the main hazards arise from:
— the high handling temperatures generally necessary;
— persistent skin contact, particularly when in solution;
— vapour emissions associated with the product when heated;
— the combustible and sometimes flammable nature of the product;
— contact in piping, tankage or other vessels by hot bitumen with water, with violent expansion to steam of more than 1 600 times its volume; this can give rise to dangerous froth-over, and may cause boil-over and rupture of the tank roof;
— attempted use of compressed air to clear pipeline blockage or suspected blockage in hot bitumen lines, or use of air for mixing in hot bitumen tanks;
— loss of containment from manufacture, storage, distribution, product handling and use, particularly of cutback bitumens and emulsions.

The assessment of risk and the consequent good practice precautions necessary to control the hazards associated with the handling and use of bitumens are described in the generic sections Health Management, Fire Prevention, Fire-fighting and Environmental Protection. Furthermore, guidance is provided specifically in relation to the various phases of the product life cycle under the headings manufacture, blending, storage, distribution, product handling and use, and sampling.
2 HEALTH MANAGEMENT

2.1 INTRODUCTION

This section gives guidance on the health hazards associated with bitumen, assessment of risks, and the consequent good practice personal protection and systems of work that should be applied to protect against them.

2.2 HEALTH HAZARDS TO WORKERS FROM HANDLING AND USE

At ambient temperatures, bitumens are solid and do not present any health hazard other than from manual handling.

Bitumen is normally manufactured, stored, distributed and handled hot, in a molten state and this results in the following potential hazards:

— thermal burns on contact;
— release of fumes that can cause respiratory tract and eye irritation;
— release of hydrogen sulphide (accumulation of hydrogen sulphide to reach concentrations that are hazardous will only occur in confined spaces, e.g. in tanks where bitumen is or has been stored and not during product handling and use).

Apart from the above, there is no evidence that bitumen is hazardous to worker health.

It is important when using bitumen to take full account of the information on its hazards contained in the latest relevant MSDS.

For generic MSDSs, see Eurobitume Material safety data sheet - paving grade bitumen and Material safety data sheet - oxidised grade bitumen. In addition, see the generic guidance in Eurobitume Safe handling of bitumen.

2.2.2 Classification and labelling for supply

Bitumen at ambient temperature is not classed as dangerous for supply under classification, packaging and labelling legislation. However, when bitumen is admixed with diluents to such an extent that the bitumen preparation may be regarded as bioavailable or flammable, its classification for supply under the current regulatory framework should be considered.

Other than cutback bitumens being flammable liquids, hard, oxidised, paving grade and polymer-modified bitumens are not classified as hazardous for supply under the Chemical (Hazard Information and Packaging for Supply) Regulations (CHIP). For further guidance, see Eurobitume Guidelines for the classification and labelling of bitumens.

Note that when carried by road or rail as a hot liquid, bitumens are classified as dangerous goods and are therefore listed in HSE Approved carriage list (see section 9.2.1).

2.2.2 Health hazards associated with exposure to bitumen

At ambient temperatures, bitumen is normally solid and immobile and so does not give rise to any acute or chronic health hazards.

Bitumen emulsions can be irritating to the skin and eyes and can also produce allergic responses in some people. Such effects arise mainly from the emulsifying agents, acids and bases used.

At high temperature, the main acute health hazards are burns and irritation of the respiratory system.


2.2.2.1 Burns
Bitumen is handled as a heated liquid at temperatures above 100 °C at some stage during processing and distribution, and when it is being incorporated in a mix or preparation or used in its final application. In its heated form, it will adhere readily to any exposed part of the body, usually causing burns before it cools.

The mechanism of a bitumen burn is:

— When hot bitumen comes into contact with the skin, it immediately adheres and forms an occlusive covering.
— As the bitumen cannot be easily removed, it continues to burn the skin until it has sufficiently cooled.
— As the bitumen cools, it contracts and as the underlying tissues are burnt, they begin to swell.
— This combination of factors mean that a bitumen burn that completely surrounds a body part, e.g. a finger or limb, can cause a tourniquet effect and shut off the blood supply, potentially leading to the death of the tissue beyond the affected site.

2.2.2.2 Inhalation
Heated bitumen evolves bitumen fumes which can cause irritation to the respiratory system and, particularly if subjected to a very high temperature (greater than 100 °C), can evolve hydrogen sulphide, which can create a significant health hazard in confined spaces. The rate of evolution increases rapidly when the product is heated to unnecessarily high temperatures.

Hydrogen sulphide is dangerous because:

— Although the odour threshold of hydrogen sulphide is well below 1 ppm, the familiar ‘bad eggs’ odour cannot be relied upon to warn of the presence of dangerous concentrations because the gas rapidly deadens the sense of smell even at concentrations of 20 ppm, which is below hazardous levels.
— Prolonged exposure to concentrations above 50 ppm causes irritation of the eyes and mucous membranes of the nose, throat and lungs.
— Any exposure to concentrations above 500 ppm can result in death.
— Levels above 700 ppm cause unconsciousness and collapse can occur in seconds.

There is normally sufficient hydrogen sulphide to cause harm near open-air work with bitumen but where there is any doubt, sampling for hydrogen sulphide should be carried out and appropriate precautions taken.

Other hazards may arise when bitumen is heated and fumes evolve when bitumen is mixed with other substances. Before introducing a bitumen into the workplace, the type, grade and mixture should be correctly identified by referring to the supplier’s MSDS. This will enable appropriate risk management procedures to be established.

In addition, handling and use of bitumens may also result in exposure to other hazardous substances, such as particulate matter in asphalt manufacture arising from drying, handling, bagging, loading and unloading limestone and other solids and from the transfer of potentially dusty materials, including their discharge into hoppers and onto conveyors, and delivery to storage silos. Such exposure to non-bituminous hazardous substances is outside the scope of this Code.

2.2.3 Health concerns with bitumen
Polycyclic aromatic hydrocarbons (PAHs) are present in bitumen but at low concentration. Some PAHs have been shown to exhibit carcinogenic potential in animal skin painting studies, e.g. benzo-(a)-pyrene has been shown to induce skin cancer.

To date there is no conclusive evidence to suggest that bitumen fumes are carcinogenic to humans. The issue of the carcinogenic potential of bitumen has been extensively studied over the last 20 years. Neither expert scientific bodies nor most regulatory bodies have classified it as a carcinogen such that, provided bitumen is handled and applied according to the appropriate guidance, exposure to its fumes does not present any cancer risk.


Whilst further work is in progress, summaries of the findings of the first phase of the IARC epidemiology study of European asphalt workers is reported in CONCAWE European epidemiology studies of asphalt workers – A review of the cohort study and its results.

2.3 HEALTH RISK ASSESSMENT
As required by the Control of Substances Hazardous to Health Regulations (COSHH), a risk assessment of activities involving the handling and use of bitumen should be performed to aid the determination of the specific issues relating to the work and the environment in which it is to be used. It will also guide the implementation of adequate control programmes in order to minimise the potential exposure to bitumen, the identification of any personal protective equipment...
HEALTH MANAGEMENT

(PPE) that should be worn and the development of training programmes for bitumen workers.

Worker exposure to bitumen fumes is controlled by national occupational exposure limits (OELs). These limits are set at a level that would not be expected to cause adverse health effects on repeated, daily exposure over a working lifetime.

2.3.1 Inhalation exposure evaluation criteria - occupational exposure limits

2.3.1.1 United Kingdom OELs

HSE Occupational exposure limits, published annually, contains up-to-date regulatory limits. The current UK OELs for exposure by inhalation for asphalt/bitumen products are summarised in Table 2.1; these are occupational exposure standards (OESs) rather than maximum exposure limits (MELs). Note that these are changing to workplace exposure levels (WELs). The OES for asphalt, petroleum fumes is directly applicable to bitumen that has not been admixed with any other material.

2.3.1.2 American OELs

Threshold limit values (TLVs) are published in ACGIH Threshold limit values and biological exposure indices for 2002. The current US TLVs for exposure by inhalation for asphalt/bitumen products are summarised in Table 2.2.

Table 2.1 UK OELs and risk phrases

<table>
<thead>
<tr>
<th>Substance</th>
<th>Long term 8 hour TWA</th>
<th>Short term 15 minute TWA</th>
<th>Risk phrases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt, petroleum fumes (OES)</td>
<td>5 mg/m³</td>
<td>10 mg/m³</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Coal tar pitch volatiles (Note 1)</td>
<td>Under review</td>
<td>Under review</td>
<td>Under review</td>
</tr>
<tr>
<td>Hydrogen sulphide (OES)</td>
<td>5 ppm/7 mg/m³</td>
<td>10 ppm/14 mg/m³</td>
<td>R26 - very toxic by inhalation</td>
</tr>
<tr>
<td>PAHs, e.g. benzo-(a)-pyrene</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>R45 - may cause cancer</td>
</tr>
</tbody>
</table>

Notes:
1. This OEL was previously applied to the measurement of bitumen fume due to its PAH content.

Table 2.2 American TLVs and risk phrases

<table>
<thead>
<tr>
<th>Substance</th>
<th>Long term 8 hour TWA</th>
<th>Short term 15 minute TWA</th>
<th>Risk phrases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt, petroleum fumes, as benzene-soluble aerosol (Note 1)</td>
<td>0,5 mg/m³</td>
<td>Not applicable</td>
<td>A4 - not classifiable as a human carcinogen</td>
</tr>
<tr>
<td>Coal tar pitch volatiles, as benzene-soluble aerosol (Note 2)</td>
<td>0,2 mg/m³</td>
<td>Not applicable</td>
<td>A1 - confirmed human carcinogen</td>
</tr>
<tr>
<td>Hydrogen sulphide</td>
<td>5 ppm (formerly 10 ppm in 2002)</td>
<td>Not applicable (formerly 15 ppm in 2002)</td>
<td>Not applicable</td>
</tr>
<tr>
<td>PAHs e.g. benzo-(a)-pyrene</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>A2 - suspected human carcinogen</td>
</tr>
<tr>
<td>Kerosine/jet fuels, as total hydrocarbon vapour</td>
<td>200 mg/m³</td>
<td>Not applicable</td>
<td>Skin A3 - confirmed animal carcinogen with unknown relevance to humans</td>
</tr>
</tbody>
</table>

Notes:
1. Pending outcome of the IARC epidemiology study
2. This OEL was previously applied to the measurement of bitumen fumes due to their PAH content.

The 'Asphalt, petroleum fumes, as benzene-soluble aerosol' TLV is intended to better represent the fraction capable of reaching those areas of the respiratory tract where it can have adverse health effects.
2.3.1.3 Other OELs

Other countries have their own OELs. Where regulatory limits are not in place, it may be necessary to derive user-working limits for mixtures containing other components; it should be remembered that the OES for asphalt, petroleum fumes can only be applied to the bitumen particulate matter of the mixture in the air. Other limits may be applicable to other components. For example, if bitumens that have been cut back with kerosine are to be sprayed, the exposure to bitumen particulate matter in the aerosol should be judged against the OES for asphalt, petroleum fumes. Similarly, it would be appropriate to consider a limit for hydrocarbons, e.g. 'kerosine/jet fuels, as total hydrocarbon vapour' for the kerosine vapour phase. See Table 2.2. Where other solvents are employed, a similar procedure should be followed.

Table 2.3 Typical inhalation exposure to bitumen fume for generic handling and use operations

<table>
<thead>
<tr>
<th>Process/ Activity</th>
<th>Occupation/Task</th>
<th>Typical exposure level (Notes 1, 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing/ storage/</td>
<td>Process operator (distillation, blowing, blending)</td>
<td>Low</td>
</tr>
<tr>
<td>distribution</td>
<td>Tanker driver - loading product for road/rail (including sampling and dipping)</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Tanker driver - unloading product from road/rail</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Laboratory technician</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Sampling (from tanks or gantries)</td>
<td>Low (Note 3)</td>
</tr>
<tr>
<td>Roofing</td>
<td>Kettle operative</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Spreader</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Other roofing operatives</td>
<td>Low</td>
</tr>
<tr>
<td>Flooring</td>
<td>Kettle operative</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Pourer</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Bucket carrier</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Troweller</td>
<td>High</td>
</tr>
<tr>
<td>Asphalt production</td>
<td>Control cabin operator</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Hot mixture plant operator</td>
<td>Low</td>
</tr>
<tr>
<td>Hot mixture asphalt paving</td>
<td>Paver driver</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Raker</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Remote raker</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Roller driver</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Screeeder</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Foreman</td>
<td>Medium</td>
</tr>
<tr>
<td>Surface dressing</td>
<td>Spraying operatives</td>
<td>Low</td>
</tr>
</tbody>
</table>

Key
Low Very little exposure
Medium Some exposure likely but well below OELs
High Exposure close to or in excess of OELs, or high exposure, likely to occur on occasions

Notes:
1 Typical exposures are grouped into three bands, subject to the processes being under good control, avoidance of product over-heating, etc. See 2.3.2.
2 The table is largely based on exposure data in IP Technical paper 84-006.
3 Low, providing sampling is carried out from upwind and greater than 0.7 m from release sources (see section 11.2).
2.3.2 Typical inhalation exposure to bitumen fume for generic handling and use operations

Table 2.3 provides a general guide to the typical personal exposure to bitumen fume concentrations compared to the current UK OELs (see 2.3.1.1) for several generic bitumen handling and use activities. Typical exposures are grouped into three bands, subject to processes or activities being under good control, i.e. under good ventilation (e.g. closed systems for some manufacturing processes, avoidance of confined spaces for indoor flooring, etc.), avoidance of product overheating, etc. The exposure bands exclude exposure reductions due to effective use of respiratory protective equipment (RPE). The onus is on the user to consider the applicability of Table 2.3 to their circumstances. Factors to consider include: particular properties of product grades; individual work geometry (e.g. distance from source of exposure); duration of exposure compared to periods of no-exposure; etc.

Note that Table 2.3 does not refer to other possible exposures by inhalation, such as to hazardous dusts encountered in asphalt manufacture and use.

Further information is provided in NIOSH Hazard review: Health effects of occupational exposure to asphalt.

2.3.3 Inhalation exposure monitoring

A reference method by which levels of inhalable bitumen fume can be measured, in particular to facilitate evaluation against the ACGIH TLV, has been published as CONCAWE Assessment of personal inhalation exposure to bitumen fume - guidance for monitoring benzene-soluble inhalable particulate matter. This is a complex sampling and analytical procedure that is only suitable for use by competent occupational hygienists supported by accredited analytical laboratories.

Note that inhalable bitumen fume exposure data determined in that way are not directly comparable to benzene soluble material (BSM) determined in the former approach.

Laboratories offering an exposure monitoring service should be accredited by the UK Accreditation Service (see http://www.ukas.com).

2.4 CONTROL OF HAZARD

Because of the potential hazards associated with exposure to bitumen and its formulated products, the first priority is to identify primarily engineering control measures to decrease the likelihood of worker exposure. If these are not practical then procedural controls, personal hygiene precautions and then PPE should be considered.

2.4.1 Engineering controls

Where hot bitumen is to be handled by persons working in places with restricted ventilation, e.g. indoors, effective local exhaust ventilation (LEV) of a suitable performance should be used in order to reduce exposure as far as possible. LEV ranges from permanently installed units typically found in manufacturing plants to portable units that provide necessary flexibility to job requirements.

2.4.2 Procedural controls

Adhering to good work practices should prevent or minimise worker exposure to bitumen fumes. In particular, because the evolution of fumes increases with increase in temperature, the guidance given in Section 10 and Annex B should be followed, and every operation should be carried out at as low a temperature as possible, compatible with efficient working but in any case below the operational maxima.

2.4.3 Personal hygiene precautions

Good personal hygiene in respect of hands and inner clothing should always be maintained in the course of work. Under no circumstances should a person who has been handling bituminous products eat, drink, smoke or go to the toilet without first washing their hands.

The application of barrier creams to the skin, prior to work with bitumen, assists in subsequent cleansing should contact occur. It should be stressed, however, that barrier creams are not adequate substitutes for gloves or other impermeable clothing and should therefore not be used as the sole form of protection.

Solvents such as petroleum spirit (gasoline), kerosine (paraffin), gas oil or diesel fuel should never be used for skin cleansing purposes because they damage the skin. Petroleum spirit, in particular, also poses a serious fire hazard.

Persons engaged in the manufacture, blending or use of bitumen at work should be provided with appropriate skin care creams for hands and washing facilities including hot water, soap and clean towels, preferably disposable.

2.4.4 Personal protective equipment

The objective in providing PPE is to prevent exposure. Personnel should be trained in the correct use of all
prescribed PPE and arrangements should be put in place for its routine inspection and maintenance. In addition, adequate facilities for storage of PPE should be provided.

Whilst determined by a specific task risk assessment, the typical PPE requirement for bitumen workers should comprise:

- protective clothing: this should shed splashes and spills away from the body by means of close-fitting cuffs and trouser leg-ends capable of overlapping footgear;
- eye protection: an approved face and eye shield;
- hand protection: heat-resistant gloves with close-fitting cuffs;
- foot protection: heat-resistant heavy duty boots, with close fitting at the top such that trouser leg-ends are capable of overlapping them. Boots are preferable to shoes, and under no circumstances should light shoes, sandals etc. be worn.

If there is a significant risk of splashing, additional PPE requirements for bitumen workers should comprise:

- head protection: full head and face protection with neck-flap fitting over the collar;
- eye protection: approved splash/impact face and eye shield.

Other items of PPE may need to be added to this list depending on the work that is being performed; the identification of these will be facilitated by a specific task risk assessment. For example, detailed PPE requirements for road tanker drivers (or similar operatives) involved in product loading or discharge operations is given in section 10.2.1.3.

Note, to comply with the requirements of DSEAR, PPE for use in hazardous areas (see Annex C) may need to have anti-static properties to avoid generating electrostatic discharges that could ignite a flammable atmosphere.

2.4.4.1 Respiratory protective equipment

Most operations involving exposure to asphalt/bitumen fumes and/or aerosols are generally below any of the relevant OESs and as such, no specific RPE exists for bitumen fumes. However, in confined spaces such as within storage tanks, self-contained breathing apparatus (SCBA) should be worn. In all other operations any oronasal (half-face), air-purifying respirator equipped with a combination of a particulate filter approved to EN 149:2001 type P1, P2 or equivalent and an organic vapour cartridge approved to EN 405 type FF A1 P1S, FF A2 P2SL or equivalent, should suffice. In addition, any powered, air-purifying respirator with a hood, helmet or loose fitting face-piece, equipped with a combination high efficiency particulate arrester (HEPA) and organic vapour cartridge can also be used. Air-line fed respirators may also be used where a suitable air supply is available.

RPE may also be required because of other operations where asphalt/bitumen fumes and/or aerosols are not the main inhalation hazards: in some circumstances, nuisance dust from aggregate operations may be a more significant hazard.

2.5 HEALTH SURVEILLANCE

Health surveillance should be applied to all three of the following conditions apply:

- there is a known health effect associated with the substance being used;
- the health effect is likely to occur in the conditions in which the substance is being used; and,
- there is a valid method for testing for the health effect.

For bitumen exposure, health surveillance should be by looking for problems arising from skin contact (see 2.2.3). Workers should be trained to inspect their skin in order to recognise the development of any abnormalities. A management procedure should be in place to allow any abnormality thus identified to be reported to a trained health professional who will take appropriate action.

Those who have worked with bituminous products regularly and who have changed jobs or have retired should be advised to continue this self-examination as a matter of prudence. This is particularly relevant in respect of mature people, since in the past, many bituminous materials were in use with little or insufficient distinction as to whether they were of petroleum or coal tar origin, or mixtures of both.

2.6 PRECAUTIONS IN CASE OF AN EMERGENCY

2.6.1 First aid

The Health and Safety (First-Aid) Regulations require employers to provide adequate equipment, facilities and personnel to enable first aid to be given where personnel are injured or become ill at work. The regulations apply to all workplaces, whatever their size, and to both employees and the self-employed. Provision of first aid resources should be determined by an assessment of the level of risk likely to be encountered in the course of work. The assessment should consider: the processes;
work methods; substances and tools used; and whether work is carried out in remote areas where third party response may not be timely. For further guidance, see HSE First aid at work.

All persons who may be required to administer first aid should be competent having received adequate training in the administration of first aid at work.

Emergency water showers, e.g. of the step-on type, and eye bath facilities should be provided at fixed sites and in larger projects where bitumen is handled at an elevated temperature.

At mobile sites, e.g. where hot spraying is carried out, where a supply of water is not available, an emergency supply, held in a readily accessible place, should be provided. This could take the form of a water-filled stored pressure extinguisher modified by the addition of a fine spray type nozzle. It should be clearly marked to indicate it is not to be used to combat fires and is for first aid use only.

2.6.2 Skin contact

The potential seriousness of bitumen burns means that the first aid required for a bitumen burn differs significantly from that used for other types of burn and it is important for all those potentially exposed to hot bitumen to be aware of this.

2.6.2.1 High temperature contact

Bitumen burns should receive medical attention without delay and burns to the eyes must be referred urgently for medical attention. Treatment should be to the following protocol:

— Burns to the skin or eye should be immediately cooled by placing the burnt area of the body under clean cold running water. This treatment should be continued until the bitumen has cooled and this should take no less than 10 minutes.

— No attempt should be made to remove the bitumen from the skin or area of the eye as it forms a sterile barrier to the affected part and will protect against infection. A bitumen plaque will normally detach itself within a few days.

— After the bitumen has set, cold wet towels can be applied to the burn area to help relieve any pain.

— Lotions and ointments should not be applied, but exposed burns can be lightly covered by sterile burn dressings to exclude air.

— Wrapping the casualty in blankets or any wool dressing should be avoided until after the bitumen has fully set.

— As shock will usually occur, the patient should be kept warm and provided with plentiful fresh air.

— No food or drink of any kind should be given to any patient who will need to attend hospital as this may interfere with subsequent treatment.

— Where bitumen encircles a limb or finger, a tourniquet effect can occur as the bitumen cools. In such circumstances, medical attention should be sought at the earliest possible moment after cooling. The objective is to maintain circulation by breaking the encirclement and this may be done by weakening the ring by dissolving or if necessary cutting it. In areas or locations where professional medical assistance cannot be obtained within a reasonable time, it may be necessary for a first-aider to take action. This will require the first-aider to cut through all the layers of bitumen in a direction that will ensure that the encirclement of the bitumen-covered area is broken. It may be necessary to perform more than one cut. A clean sharp blade should be used.

Figure 2.1 reproduces the Eurobitume Bitumen burns card. This gives first aid guidance on actions that should be taken in the event of a burn. Copies of the card are available from bitumen suppliers. It should be displayed in prominent positions at large sites, e.g. bitumen plants, or distributed in the form of a pocket-size card to peripatetic workers. In addition, it should accompany the patient and be placed in a prominent position before transport to doctor or hospital.

2.6.2.2 Low temperature contact

In the event of non-heated bituminous products entering the eye, the action should be to flush it with copious quantities of clean water. If irritation persists, the patient should be referred for medical attention. Low temperature skin contact normally does not require first aid but the product should be washed off the skin immediately after any contamination and at the end of each work period, with a proprietary skin cleanser, soap and water. Aftercare skin preparations should be used after washing to assist in replacing natural oils.

2.6.3 Exposure by inhalation

Only inhalation of bitumen fume that contains hydrogen sulphide is hazardous in the short term.

2.6.3.1 First aid for persons affected by hydrogen sulphide

Rescue should only be carried out by competent persons who are adequately equipped with SCBA to enter suspect atmospheres and having a second person similarly equipped standing by. Persons affected by
inhalation of hydrogen sulphide should be removed as soon as possible to an uncontaminated area in the fresh air; if available, oxygen should be administered.

Medical assistance should be called without delay and immediate resuscitation procedures conducted by a competent person as follows:

— Check for consciousness by gently shaking the shoulders and shouting loudly 'Are you all right?'
— If conscious, turn the casualty on to their side, taking care of any possible injury, and reassess regularly.
— If there is no response, place on the back, open the airway by tilting the head and lifting the chin. Listen and feel for signs of breathing for 10 seconds.
— If there is breathing, place the casualty onto their side, and check for continued breathing.
— If there is no breathing, open the mouth and check for any visible obstruction, including broken teeth.

Leave well-fitting dentures in place.
— Give two rescue breaths, checking that the chest rises and falls. Commence external cardiac compression by applying pressure with the heel of one hand with the other hand on top, placed over the lower half of the breastbone; the ratio should be 15 compressions for every two rescue breaths. Continue until medical assistance arrives.
— If the casualty shows signs of life, assess whether the breathing is adequate (more than the occasional gasp), and place in the recovery position, on the side. If available, administer oxygen by mask at 100 %. This should continue until medical assistance arrives.

Further guidance on resuscitation procedures is provided in BMJ The 1998 European Resuscitation Council guidelines for adult single rescuer basic life support and BMJ Cardiopulmonary resuscitation in adults.
Figure 2.1 - Eurobitume *Bitumen burns card* (courtesy of Eurobitume)
Figure 2.1 - Eurobitume *Bitumen burns card* (courtesy of Eurobitume) (continued)
FIRE PREVENTION

3.1 INTRODUCTION

This section provides guidance on the fire hazard associated with bitumen and how best to control it throughout the product life cycle, thereby protecting people, property and the environment.

Employers should assess the safety risks arising from their handling and use of bitumen: they should consider the hazardous properties of the products, the quantity used, circumstances of use, and the means by which its use could affect the safety of employees and other people, property and the environment. Specifically, the risk assessment should consider the likelihood of forming a flammable atmosphere, the likelihood of a source of ignition being present, and foreseeable fire scenarios should ignition occur. The risk assessment will enable employers to decide what they need to do to eliminate or control risks, for example by limiting, as far as is reasonably practicable, the extent of production of flammable atmospheres and by avoiding sources of ignition in areas where flammable atmospheres might be present. In addition, Section 4 provides guidance on preparing for and tackling emergencies should ignition occur. This approach is consistent with DSEAR, which applies to employees and the self-employed at most workplaces.

3.2 MECHANISM OFignITION OF BITUMEN

Small quantities of the vapours of hydrocarbons in air can form a flammable mixture that can be ignited by a flame, hot surface or heating element, spark or other source of ignition. This is true of the vapours that can collect in the confined ullage space of a storage tank, or other enclosed containers containing heated bitumen.

Ignition in a confined space within a tank leads to a transient flame, because of the limited availability of air for combustion, but the heat generated is likely to be associated with a rise in pressure that may cause structural damage to the tank.

Where continued access of air is possible, either because the confinement is only partial in normal working, or as a result of structural damage, the flame may no longer be transient and then lead to continued burning as a stabilised fire at atmospheric pressure. In this case, fire-fighting is necessary. See Section 4.

3.3 CONTROL OF FLAMMABLE ATMOSPHERES

Hydrocarbon vapour becomes flammable when its percentage in air rises to as low a figure as about 1 % by volume (equivalent to about 45 g/m³ of air); below this the mixture is said to be 'too lean to burn', or 'below the lower flammable limit (LFL)'. The flammable range continues - often with explosive potential in the confined space of a tank - until the percentage of vapour reaches a higher level in air of about 8 % by volume, when it is said to be 'above the upper flammable limit (UFL)', or 'too rich to burn'.

The normal procedure for controlling flammable atmospheres is to use the IP classification of petroleum and its products (see Annex A) or equivalent, and then to apply layout, construction, operational codes and control measures, as appropriate to the product class.

Avoiding loss of control that could lead to a fire
relies on the continuing integrity of those measures; in particular, safety-related control measures such as process level control instruments, or pressure/explosion relief systems. Such hardware and their software should be designed, installed, operated and maintained so that they have a sufficiently low likelihood of failure or malfunction. For example, flammable atmospheres can develop for all grades of bitumen in poorly ventilated ullage spaces by overheating the product locally by a hot fire-tube heating unit operating in an unagitated tank or in a tank where a heavy coke build-up has been allowed to occur. For this reason, the necessity of accurate temperature control when heating bitumen tanks is stressed in sections 8.4.3 and 10.2.2.

When using the IP classification of petroleum and its products a particularly important factor in determining design and layout, as well as operational precautions, is the subdivision of Classes II and III according to whether the substance is to be handled or used at temperatures below its flash point (subdivision (1)), or above it (subdivision (2)).

In the case of bitumen, this procedure is directly applicable only to cutback grades. See 3.3.1. Alternative approaches are necessary for bitumens other than cutback grades. See 3.3.2.

### 3.3.1 Cutback bitumens

Bitumens cut back with kerosine normally have flash points in the Class III range (see annex A.2). They are regularly stored, handled and used at temperatures above their flash points and should therefore normally be considered as Class III(2) products. For storage, see section 8.2.2.

Cutback grades made with solvents more volatile than kerosine can have flash points in the Class II range, and when stored, or handled or used at temperatures above their flash point they should be classified as Class II(2) products. For storage, see section 8.2.2.

Flammable atmospheres in cutback bitumen operations can occur:

— in tank ullage spaces at normal working temperatures;
— near tank vents, particularly during heating and filling;
— near mixing and spraying operations.

Sources of ignition should be controlled in these areas. See general guidance in 3.4 and product handling and use guidance in section 10.8.1.

Cutback bitumens at normal working temperatures often produce atmospheres above the UFL such that they cannot be ignited without addition of air. However, this should not be relied upon as a safeguard against ignition since contact with air, e.g. at vents and other tank openings, may result in dilution to within the flammable range and thence the possibility of ignition.

For the handling of the cutback diluents, see section 8.2.3.

### 3.3.2 Bitumens other than cutback grades

Paving, hard and oxidised grade bitumens require different handling to prevent the formation of flammable atmospheres.

Flash points of these products determined by conventional test methods are normally well in excess of 100 °C. They therefore fall in the Unclassified category of petroleum products. However, as noted in annex A.3, the flash point test of bitumen or other residual product held under heated tankage conditions is not a reliable indicator of the presence or absence of a flammable atmosphere. This is because highly volatile hydrocarbon vapours may have evolved and built up in the confined tank ullage space above the bulk heated product that cannot be detected by flash point test. Thus, the flammability of non-cutback bitumens is further distinguished by whether they are handled in open air or stored in confined heated tankage.

#### 3.3.2.1 Non-cutback bitumens handled in the open air

Because of good natural ventilation by wind, the flammable atmospheres that may accumulate over a period in the confined ullage space of an enclosed heated tank do not normally persist when these heated products are handled in open-air locations.

Notwithstanding this, products heated in kettles require adequate temperature control, to avoid overheating to the ignition temperature of the bitumen (see 3.4.3 and annex B.7). A sustained fire may otherwise result.

#### 3.3.2.2 Non-cutback bitumens stored in confined heated tankage

Under confined heated storage conditions, flammable atmospheres can occur in:

— tanks when storage temperatures exceed the maxima set out in annex B.2;
— some oxidised grade production plant rundown tank ullage spaces at temperatures below the maxima set out in annex B.2;
— tanks where misting has occurred due to splash filling;
— tanks where contamination with lower flash point substances has occurred;
— near vents from any such tanks.

Flammable atmosphere formation is determined by
product grade, which in turn is dependent on composition and susceptibility to thermal activity:

— Heated bitumens can be prone to gradual evolution into the confined ullage space of a tank of vapour consisting, in variable proportions according to type, of methane, 'other hydrocarbons' (typically in the C₁ range but extending in some cases to the C₅ range), carbon monoxide, carbon dioxide, water vapour, and in some cases hydrogen sulphide.

— The degree of the thermal activity that produces these flammable vapours is grade dependent. Under heat, there is less activity with the 'straight' paving and hard paving grade bitumens, compared to greater activity with oxidised grades, coupled with the higher temperatures at which they are stored. The reactions occurring in the air oxidation process result in newly blown material being more reactive and susceptible to thermal after-cracking. This potential for thermal cracking of freshly air-blown bitumen is observed also when monitoring tank ullage spaces; this decreases with time, or when the product is transferred from the initial tank to a second tank even when both are held at the same temperature.

These behavioural differences are taken into account in Section 6, in distinguishing between the precautions that should be taken in respect of rundown tanks that receive product direct from the manufacturing step, and in particular for the oxidised grades, compared to downstream oxidised grade tanks and all categories of tankage for the non-oxidised grades.

Where there is a possibility of a flammable atmosphere occurring with such oxidised grades, additional control measures may be required. See 3.4.5, sections 6.4.1, 6.4.2, and 8.3.8.

3.4 CONTROL OF SOURCES OF IGNITION

In addition to controlling the formation of flammable atmospheres, the risk of fire should be reduced by controlling possible sources of ignition, both electrical and non-electrical, particularly near bitumen storage, handling and use, such as around tank vents and other openings.

Locations in or around establishments where flammable atmospheres may occur from time to time should be subject to area classification, as part of the risk assessment under DSEAR. This aims to avoid ignition of those releases.

The principles of area classification are described in Annex C. The approach is nominally to divide installations into hazardous and non-hazardous areas based on the likely presence and duration of a flammable atmosphere, and then to control potential sources of ignition, such as fixed and mobile electrical equipment and hot surfaces, to reduce to an acceptable level the probability of their coincidence.

Note that it is not the aim of area classification to guard against ignition of major releases of flammable products following catastrophic failure (e.g. rupture of a storage vessel); the incidence of such releases should be kept as low as reasonably practicable by adequate design, construction, maintenance and operation.

Guidance for classification of areas in and around bitumen storage installations is given in sections 8.2.1-8.2.4 in accordance with IP Area classification code for installations handling flammable fluids.

Whilst the control of flammable atmospheres and provision of suitably protected equipment should reduce the possibility of ignition, those who may work in or around hazardous areas should be provided with suitable information, instruction and training on the necessary control measures.

In accordance with the requirements of DSEAR, areas where flammable atmospheres may occur should be suitably marked; this will remind those working there of the need to only use suitably protected equipment.

3.4.1 Electrical and non-electrical equipment

Electrical and non-electrical equipment for use in hazardous areas should be selected in accordance with the risks identified in the area classification (see annexes C.4 and C.5). It should be designed and constructed to appropriate standards, and operated, inspected and maintained such that the protection afforded by those standards is not compromised. In this context, electrical equipment comprises fixed and portable apparatus, earthing and bonding systems, cathodic protection, instruments, etc.

3.4.2 Hot work

Area classification is not intended to apply during non-routine operations such as maintenance, due to the possibility of release of flammable substances in quantities greater than would be expected during normal operation. For example, gas-freeing of process plant by forced ventilation can create vapour clouds that spread far beyond the normal hazardous zone, such that normal area classifications should be suspended.

At establishments where there are numerous hazardous areas, it may be more convenient to declare an ignition source control area in and around all installations handling bitumen or associated petroleum products following catastrophic failure (e.g. rupture of a storage vessel); the incidence of such releases should be kept as low as reasonably practicable by adequate design, construction, maintenance and operation.
products whether or not they are hazardous for the purposes of area classification. This is typically applied to bitumen tankage areas (see section 8.6.4). Within ignition source control areas, any hot work using naked lights, chipping tools, welding and cutting equipment or machines with hot surfaces that might be sources of ignition for flammable vapours, should be covered by a permit to work (PTW). PTW systems should be part of the operator’s management system; this will ensure that hot work is rigorously defined, monitored during its execution and formally reviewed before being declared complete. Issue and monitoring of PTWs at larger sites may be the responsibility of an occupational fire brigade. For introductory guidance on PTW systems, see IP Design, construction and operation of petroleum distribution installations, whereas for detailed guidance, see HSE Guidance on permit-to-work systems.

Hot work PTWs should consider the foreseeable conditions that could prevail during the work life cycle, and specify the:

- nature of the task;
- extent of the area within which the work is permitted;
- period of time over which the permit is valid;
- competencies of those who will be carrying out the work;
- precautions to be taken before commencement of the hot work, including:
  - preliminary emptying and cleaning of tanks and pipework (see section 8.6.3);
  - gas testing using gas detectors for both the presence of flammable atmospheres and conditions for safe entry of personnel into tanks and vessels (see section 8.6.2);
  - spading or blanking off of connections to provide positive isolation;
  - disconnection of necessary electrical equipment and other services;
- precautions to be taken during the hot work, including:
  - the means by which the area is to be kept free from flammable gases and vapours;
  - measures to avoid the spread of any fire or sparks, including the provision of fire guards, additional standby fire extinguishing equipment, fire detectors, etc. (see Section 4);
  - the means for detecting whether any heat generated by the hot work is capable of locally vaporising heavy product material remaining on surfaces such as walls, roofs and tank bottoms (see section 8.6.4);
  - procedures to be followed in an emergency, such as what actions to take where flammable products are released elsewhere which could affect the work area;
- the means by which the area is monitored for flammable gases and vapours;
- precautions to be taken after the hot work has concluded, including:
  - verification of completion of hot work;
  - removal of isolations, such as those applied to tanks and pipework, and reinstatement of electrical equipment and other services.

Additional procedural controls for hot work on bitumen storage tanks are given in section 8.6.4.

The ignition source control area to be designated in the work permit should include:

- as a minimum, all areas classified as hazardous, in accordance with 3.4;
- all other areas in which flammable atmospheres might be present (e.g. arising from possible local loss of containment elsewhere) or be produced by the hot work;
- all areas from which any spark, flame, high temperature or residual oxygen (from oxy-acetylene cutting) might be transmitted from the hot work to an area that could contain a flammable atmosphere (e.g. ducts, drains).

3.4.3 Flash point and ignition temperatures of bitumen

Flash point and ignition temperature are entirely different properties of a substance and are defined as the temperatures at which it will ignite, in the presence or absence of a flame respectively, under closely controlled laboratory conditions. Under practical conditions of storage and use, auto-ignition may occur at far lower temperatures. The ignition temperature is not an absolute property of a substance and depends upon several factors, which include:

- the temperature of surfaces in contact with the substance;
- the contact time between the substance and the hot surface;
- the area of the hot surface in contact with the substance;
- the air flow and cooling rate;
- whether the surface is 'active' or inert (see 3.4.4);
- how near the vapour/air mixture is to a stoichiometric concentration;
- the physical characteristics of the substance.

Heavy, higher boiling petroleum products such as residual fuel oils and bitumens tend to have ignition temperatures considerably lower than those of lower flash point such as kerosine or gasoline. Thus, for the
former, there is a convergence between flash point and ignition temperature.

Auto-ignition of bitumen can thus occur when it is exposed to air at temperatures that, depending upon grade, can be as low as 250 °C. Leaks and other exposure of bitumen to air at such temperatures should therefore be avoided, particularly where other flammable substances are present. Similarly, this guidance applies to heating oils used for heating bulk bitumen (see 3.5.2).

Using oxidised bitumens as a roofing adhesive (see section 10.5) requires heating to achieve the necessary low viscosity whilst the bitumen has a high softening point and low temperature susceptibility. For quality and safety, health and environmental protection reasons, the bitumen should not be overheated. The situation is exacerbated if the bitumen is kept hot for a long time with the heating kettle lid open, since its viscosity will increase due to oxidation, requiring even higher temperatures to achieve working viscosity. For guidance on necessary control measures, see section 10.4.2.

### 3.4.4 Auto-ignition of oil-impregnated materials

Self-heating leading to auto-ignition at the surfaces of, or within, porous or fibrous materials impregnated with oils or bitumens, can occur at temperatures as low as 100 °C. Oil and bitumen contamination of thermal insulation materials and the accumulation of oily rags or similar materials near hot surfaces should therefore be avoided, especially in hazardous areas, and lagging should be replaced where necessary by a non-absorbent type of insulation.

### 3.4.5 Pyrophoric deposits

A pyrophoric deposit is a solid deposit, normally formed in an oxygen-depleted environment, which can self-heat when its temperature or the surrounding oxygen concentration is increased. Such ignition is a special case of auto-ignition. The self-heating process can generate flammable vapour from product in contact with the deposit, as well as providing heating to the ignition temperature.

Carbonaceous deposits, which can be pyrophoric, occur on the roofs and walls of heated bitumen tanks due to wetting by liquids or condensation of vapours, followed by thermal degradation. In the ullage spaces of hot tanks the surface layers of these deposits go through a continuous oxidation process that is accelerated by any increase of temperature. This consumes oxygen and generates oxides of carbon, water vapour and small quantities of various hydrocarbon gases. It is a cause of the oxygen depletion that has been observed in many bitumen storage tanks that are not blanketed with inert gas.

The oxidation process normally produces no significant local temperature rise. Self-heating of deposits leading to auto-ignition can occur, particularly where there is either a sudden increase of the oxygen concentration at the active surface of the deposit or a change of operating conditions that increases the temperature of the deposit. See section 8.4.7.

Iron sulphide deposits, which can be pyrophoric, occur inside mild steel equipment wherever the atmosphere in contact with the metal contains hydrogen sulphide and water vapour and is largely depleted of oxygen. See section 8.3.8. If these deposits subsequently meet air, in the dry state, they can self-heat from cold sufficiently to ignite any flammable atmosphere present.

In process plant and tank ullage spaces likely to contain pyrophoric deposits special precautions are necessary to avoid the simultaneous occurrence of flammable atmospheres and the conditions necessary for self-heating of the deposits.

It was noted in 3.3.2.2 that the probability of developing a flammable atmosphere in a heated bitumen tank is most likely to be associated with the receipt of freshly blown oxidised grades into rundown tanks; this is due to rundown tanks becoming susceptible to overheating in the presence of air at temperatures below those at which deposits from other grades of bitumen have been found to become active.

For precautions to avoid such circumstances, see section 6.4.1.

### 3.4.6 Static electricity

The electrical conductivity of liquid bitumen is such that it does not accumulate electrostatic charge when flowing through piping or loading systems into tanks or trucks. It is therefore not necessary for this reason alone to ensure electrical continuity by bonding the pipework of systems handling liquid bitumen; in any case, earthing and bonding of tanks is ordinarily provided because of the risks from lightning. See IP Electrical safety code.

Notwithstanding this, it is noted in annex A.2 that, irrespective of the flash point, a flammable liquid when finely dispersed as mist, foam or fine spray can be ignited. Although the liquid bitumen itself is not a static accumulator, a charged mist could be generated by splash filling, since a conductive path will not exist. If a large volume such as a storage tank were to be filled with charged mist this could lead to the possibility of a spark discharge of incendiary magnitude being generated. Splash filling of bitumen or cutback bitumen.
tanks therefore should be avoided (see section 8.3.3). Because of their smaller volume, the above charge effect is not significant when loading a bitumen road tanker or rail wagon, although it is good operational practice to avoid splash filling.

3.5 FIRE PRECAUTIONS FOR DILUENTS, HEATING OILS AND FUELS USED AT BULK BITUMEN INSTALLATIONS AND USER FACILITIES

3.5.1 Classification of diluents

Diluents such as kerosine used in the blending of cutback bitumens produced to BS 3690 specifications normally have a flash point which places them in the Class II(1) range, since they will be stored at temperatures well below this (see annex A.1). For their storage, see section 8.2.3. If other diluents are used, their flash points should be reviewed against the classification criteria given in annex A.1; if they fall into Class I, then more stringent precautions will be necessary in their handling and use.

3.5.2 Heating oils for heating bulk bitumen

A variety of heating oils are used for heating purposes in installations handling bulk bitumen. Heating oils such as industrial distillate grades are stored and handled in the Class II(1) or III(1) condition, i.e. at temperatures below their flash points. The guidance regarding storage, including grouping and spacing, secondary containment and area classification given in section 8.2.4 applies.

In larger installations residual (black oil) heating oils may be used, which fall into the Unclassified category (see annex A.3); they should be stored and handled at temperatures below their flash points.

For other general guidance on the design, location etc. of heating oil tanks, see IP Design, construction and operation of petroleum distribution installations.

Heating oils may be used at temperatures of up to 250 °C, and as described in 3.4.3, may become susceptible to auto-ignition; as a control measure, they should be assessed annually for oxidation to determine if partial or complete replacement is required.

3.5.3 Liquefied petroleum gas fuel for heating bitumen in user applications

Liquefied petroleum gas (LPG) may be used as a heating fuel on product user sites, including mobile facilities (see sections 10.4 and 10.8); appropriate precautions are needed to ensure adequate safety in its handling and use. For further guidance, see LPGA Safe and satisfactory operation of propane-fired thermoplastic and bitumen boilers, mastic asphalt cauldrons/mixer, hand tools and similar equipment; Storage of full and empty LPG cylinders and cartridges; Containers attached to mobile gas-fired equipment; and The storage and use of LPG on construction sites.
4

FIRE-FIGHTING

4.1 INTRODUCTION

This section provides guidance for bitumen fires on necessary organisational, planning, human and equipment resources, the principles of attack, approaches for small and large fires, and the inspection and maintenance of equipment. Its scope primarily covers the protection of fixed installations.

4.2 ORGANISATION

4.2.1 Fire safety policy and fire risk assessment

The manager in control of an installation that warrants protection should ensure that a fire safety policy is established, implemented and regularly monitored and reviewed.

A competent person should conduct a fire risk assessment of the installation; this should assess potential impacts of foreseeable fire scenarios on people, property and the environment. In particular, this should consider issues such as:

- occupancy of buildings;
- the identity, quantity and manner of use of dangerous substances;
- ‘domino’ potential on and from neighbouring installations;
- environmental consequences (e.g. of fire-fighting water run-off);
- identification of flow paths for burning bitumen.

The fire risk assessment should also consider mitigatory measures such as:

- manual or automatic fire detection;
- fire protection;
- local government fire and rescue service (FRS) capability and response time (based on a worst case scenario);
- availability of fire-fighting media;
- mutual aid assistance from neighbouring installations or contract emergency response service providers;
- measures necessary to contain the flow of burning bitumen, such as secondary containment.

The fire risk assessment should identify the measures necessary to protect adequately the installation; this should be proportionate to the risks such that for smaller sites storing, handling and using product, it may require competent persons to implement emergency procedures, such as raising the alarm, using first attack equipment and calling the FRS who would provide the main response. For larger bitumen manufacturing and storage sites, the risk assessment may require more rigorous arrangements such as further fire protection measures and an adequately staffed and competent emergency response team, and possibly an occupational fire brigade provided with necessary fire-fighting equipment.

Whatever the risks at the installation, the site manager should seek the co-operation of FRS when planning their fire-fighting procedures. Planning for fire-fighting should be carried out in conjunction with the initial planning of the site layout, as adequate road access will be needed such that mobile appliances can be deployed or concentrated at the location of the fire and in the best position for the attack to be mounted bearing in mind variations in wind direction. These
access routes may also serve as means of escape in the event of fire outbreak.

4.2.2 Emergency plans

Emergency plans should be formulated, including procedures for:
- raising the alarm in case of fire;
- means of evacuation;
- where applicable, calling the emergency response team or occupational fire brigade, otherwise calling the FRS, and, when required, the police and ambulance;
- first attack on any fire;
- fire-fighting command and the transfer of command as the FRS arrives;
- main attack fire-fighting (where an emergency response team or occupational fire brigade is available), mitigation of damage (where an emergency response team or occupational fire brigade is available), managing fire-fighting water in order to prevent pollution (see section 5.5);
- signalling the end of the emergency;
- incident investigation and reporting;
- managing communications with the media;
- restoring the situation to normal.

The emergency procedures should be proportionately communicated to those employed at the site, contractors and peripatetic workers (e.g. visiting road tanker drivers), visitors, and people off-site who might be affected; some may only require understanding of the first few points above. In addition, the role of pertinent peripatetic workers at other sites should be considered: for example, road tanker drivers may be the first people to detect a fire at a customer site during a product delivery. Simple notices should be posted at main access points within and around the site, indicating the actions to be taken both on discovering a fire and on hearing the fire alarm.

Emergency telephone numbers should be posted prominently at communication centres within the site. These should be checked frequently for accuracy and updated as necessary.

Emergency plans should also consider off-site fire scenarios, e.g. at product use locations or during distribution of products by road tanker (see IP Code of practice for the development of a response plan for significant incidents involving petroleum road tankers).

Larger bitumen manufacturing and storage sites subject to the requirements of The Control of Major Accident Hazard Regulations (COMAH) require proportionately more rigorous on-site emergency plans.

4.2.3 Training and competence

Personnel working at a site, including peripatetic road tanker drivers, should have instruction and regular drills in emergency procedures, including first attack fire-fighting. They should be familiar with all types of fire extinguisher provided (see 4.4). Trained, but unpractised, operatives may need to use several extinguishers before fire-fighting is effective.

Occupational fire fighters should have the necessary knowledge and skills in main attack fire-fighting (see 4.5); competence in their roles should be maintained through regular training. Emergency response teams should have proportionate competence.

There should be participation in joint exercises with the FRS.

4.3 PRINCIPLES OF FIGHTING BITUMEN FIRES

The characteristics of bitumen that are most significant in determining the approaches to be taken when fighting bitumen fires are:

- When on fire bitumen becomes a mobile liquid that can readily flow, spreading the fire.
- Large bitumen fires can be difficult to extinguish because of the high heat content of the liquid.
- Direct application of water to the surface of a bitumen pool under fire conditions produces a froth of bitumen due to expansion of the water to steam which is likely to boil-over, spreading the fire and endangering personnel. Straight water jets should never be used; application of water should only be by fog or spray nozzle.
- Unburnt liquid bitumen can be heated by the fire to a temperature well above its ignition temperature, making it necessary to not only extinguish the flames and cool the surroundings but in order to avoid re-ignition, to cool the product bulk before leaving it in contact with air.
- Bitumen burns with a dense brown or black smoke, severely reducing visibility downwind of the fire.

The strategy to be applied when fighting a bitumen fire depends very much upon the quantity of product involved. However, as an initial measure to limit propagation of a fire, the heating circuits or appliances to tanks and kettles should be switched off as soon as practicable.
### Table 4.1 Selection of portable fire extinguishers for different fire classes and types

<table>
<thead>
<tr>
<th>Class</th>
<th>Fire Type</th>
<th>Water</th>
<th>Foam</th>
<th>Carbon Dioxide</th>
<th>Steam Lance</th>
<th>Dry Chemical</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Materials (wood, paper, fabric etc.)</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>B</td>
<td>Flammable liquids (including bitumens)</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>C (Note 1)</td>
<td>Flammable gases (LPG, natural gas)</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>-</td>
<td>Fires around live electrical equipment</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Note:

1. Class C fires are best extinguished by turning off the supply of flammable gas or vapour, to avoid accumulation of unburnt combustible material that could cause an explosion hazard.

### 4.4 SMALL FIRES

Small bitumen fires from leaks or spills can be extinguished using dry chemical (powder), foam, water spray, steam lance, or carbon dioxide. The use of steam, foam and water spray should be avoided where it is not practicable to isolate the electricity supply from equipment near the fire.

Dry chemical extinguishers when used in the open air are effective only on very small bitumen fires. Carbon dioxide extinguishers when used in the open air are effective only on small bitumen fires (typically less than 1 m² pool area).

Where the bitumen remains in contact with a high temperature surface, as it might do in the case of a leak from a hot process flange, application of the extinguishing medium should be continued until the surface has sufficiently cooled to avoid re-ignition. Steam lances are particularly useful in these circumstances. Dry chemical and carbon dioxide extinguishing agents have limited cooling power.

The use of water jets directly on to bitumen pool or kettle fires should be avoided because of their tendency to spread the product by producing froth.

If practicable, it is advantageous to replace the lid, at least partially, on fires in kettles. The extinguishing agent should then be squirted under the lid.

#### 4.4.1 Provision of first attack equipment

Table 4.1 gives general guidance on the types of extinguisher to be used against the various small fires that can occur in bitumen handling areas, and those applicable to other fire risks present.

Generally, portable (typically 10 kg) dry chemical extinguishers are preferred for first attack on small bitumen fires. Alternatively, portable film-forming fluoroprotein (FFFP) foam extinguishers may be provided but these should not be used around electrical equipment unless the power supply is first isolated.

Table 4.2 gives guidance on the minimum numbers of portable fire extinguishers that should be provided in smaller bitumen storage, handling and use facilities. In many cases, this is subject to there being a minimum of two extinguishers at any single location irrespective of its size, in case the first fails to operate. Additional portable extinguishers should be provided in these areas whenever hot work is in progress or open fires are in use.

Portable extinguishers should be located conveniently for access and permanently located extinguishers should be made conspicuous by coloured background panels, both to assist in visual identification and to aid checking against loss.

Where low pressure steam is available, steam lances may be provided to extinguish small fires and avoid ignition at persistent leaks in hot process areas.

In the case of a fire near live electrical equipment, water, aqueous foam or steam should not be used until the power supply has been isolated. Dry chemical extinguishers may be used on electrical fires, but their use can cause damage to equipment.
In larger plant areas and on jetties, wheeled extinguishers (typically 50 kg) in numbers appropriate to the size of the operation should backup portable extinguishers. To facilitate deployment, access routes should be kept clear.

Immediate application of the above equipment by personnel well trained in its use can often prevent the escalation and spread of a small fire.

Table 4.2 Minimum provision of portable fire extinguishers in smaller storage, handling and use facilities

<table>
<thead>
<tr>
<th>Location/Function</th>
<th>Unit of area or installation</th>
<th>Extinguishers per unit area (Note 1)</th>
<th>Type</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product warehouse, package filling shed or open package-storage area</td>
<td>230 m² floor area</td>
<td>2</td>
<td>Foam or dry chemical</td>
<td>There should be a minimum of two extinguishers provided, however small the area.</td>
</tr>
<tr>
<td>Offices and stores for dry goods</td>
<td>90 m²</td>
<td>1</td>
<td>Water</td>
<td>There should be a minimum of two extinguishers provided, however small the area.</td>
</tr>
<tr>
<td>Pump house (pumps mainly electrically driven)</td>
<td>45 m²</td>
<td>2</td>
<td>Dry chemical or CO₂</td>
<td>Locate extinguishers in diametrically opposite positions. Where a low-pressure steam main is available, a steam lance should be provided.</td>
</tr>
<tr>
<td>Electrical switch house</td>
<td>45 m²</td>
<td>1</td>
<td>Dry chemical or CO₂</td>
<td>There should be a minimum of two extinguishers provided, however small the area.</td>
</tr>
<tr>
<td>Road tanker or rail wagon loading/ unloading gantry</td>
<td>Group of up to 2 loading points</td>
<td>1</td>
<td>Foam or dry chemical</td>
<td>There should be a minimum of two extinguishers provided, however small the area.</td>
</tr>
<tr>
<td>Ship discharge or small craft loading/ unloading berth</td>
<td>Group of loading/ discharge points</td>
<td>2</td>
<td>Foam or dry chemical</td>
<td>There should be a minimum of two extinguishers provided, however small the area.</td>
</tr>
<tr>
<td>Road tankers transporting bitumen</td>
<td>Per vehicle</td>
<td>1</td>
<td>Foam or dry chemical</td>
<td></td>
</tr>
<tr>
<td>Delivery locations (close proximity to the delivery flange)</td>
<td>Per delivery point</td>
<td>1</td>
<td>Dry chemical</td>
<td>To be provided by the customer in addition to extinguisher on road tanker.</td>
</tr>
<tr>
<td>Mobile cutback bitumen spray-vehicles</td>
<td>Per vehicle</td>
<td>2</td>
<td>Foam or dry chemical</td>
<td>Locate extinguishers on opposite sides.</td>
</tr>
</tbody>
</table>

Note:
1   Extinguishers should typically be circa 10 kg portable units.
4.5 LARGE TANK FIRES

A fire in a tank usually starts as an internal explosion and, if the roof remains largely intact and the appropriate service facilities exist, can often be extinguished by injecting steam or inert gas into the ullage space.

Extinguishing a major fire in bulk bitumen tankage can be extremely hazardous to fire fighters; fire attack should only commence when they are aware of the hazards, the principles described in 4.3, and have the necessary competence, command organisation, staffing level, extinguishing media, equipment and PPE.

Water spray, when used properly, is the best medium for fighting large, open, bitumen pool fires, as for example a fire in a tank where the roof has largely blown away. Straight water jets should not be employed. Fog or diffuser nozzles should be used where their 'throw' will be sufficient. These should be directed to allow the water droplets to land gently on to the bitumen surface. If it is not practicable to reach the fire using fog or diffuser nozzles, high-pressure water jets should be directed into the air upwind of the fire so that the water falls as droplets through the flames on to the bitumen surface.

Foam may also be used, again subject to attainable reach, as an alternative to spray or fog as a means of gently applying water-cooling to the fire.

Many fire-fighting foams break down rapidly when applied to hot bitumen surfaces hence FFFP foam should be used, because of its better resistance to burn-back. Nevertheless the use of foam can help to ensure that the water used is well dispersed, thereby reducing the risk of froth-over; this is particularly relevant where access for water spray to the burning surface is hindered, as in the case where part of the tank roof remains in place, or buckling of the shell has occurred. Because of possible froth formation, foam application should be reduced from normal rates to about 1-2 L/min./m² of surface area. This is about 20 to 40 % of the rates for general petroleum fires given in IP Fire precautions at refineries and bulk storage installations.

Whichever means is used, the water as foam or spray should be applied only intermittently to the burning bitumen pool surface; however, there will be a critical minimum application rate of extinguishing agent, depending on the circumstances, below which fire-fighting is ineffective, and which will need to be exceeded. Application should be temporarily and immediately discontinued at the first sign of froth-over. This may be indicated by the appearance of white smoke; personnel should be always alert and prepared to cease applying extinguishing agents and withdraw quickly from the area. When frothing subsides, foam or spray application may be resumed and continued carefully, repeating this process until the fire is extinguished.

Throughout such operations, it is important to permit only the minimum number of personnel required to staff the appliances in the fire area.

Where, in addition to the above main operations there is additional water capacity available, this can be used as cooling water from straight hose streams played on to the tank shell to cool the hot surface, provided such streams can be controlled so as not to enter the tank. Cooling water can also be employed to protect adjacent fixed roof tanks or other property.

To protect an adjacent tank against heat radiation from a burning tank, water needs to be applied to the exposed wall area (usually half the total wall area of the tank) and to the roof. The rate of application of water should be 2 L/min./m², according to IP Fire precautions at refineries and bulk storage installations. The water application should be such that all the exposed surface of the tank etc. is wetted evenly.

4.5.1 Avoidance of re-ignition

After fire extinction, any remaining bitumen pool should be protected against re-ignition until the bulk has cooled to the normal storage temperature at which ignition will be unlikely. This can usually be done by snuffing/blanketing steam in which a gentle water spray is applied over the surface to blanket the surface with a steam layer.

Cooling of the bulk product remaining in a tank after a fire is best achieved by applying water onto the outside of the tank, taking particular care not to allow the water to enter the tank. Where the thermal insulation on the tank remains intact, this can be a prolonged process.

4.5.2 Provision of main attack equipment

The equipment necessary to support the main attack on an established fire in a bitumen installation depends upon its size and complexity and the foreseeable scenarios identified in the fire risk assessment (see 4.2.1).

Of prime importance are having an adequate:
— supply of water at a sufficient pressure to extinguish the largest tank surface fire likely to occur and for the simultaneous protection of adjacent property. See application rates in 4.5;
— supply of hoses, branches, fog or diffuser nozzles and foam makers;
— stock of foam, preferably FFFP (see 4.5).
Depending on the outcome of the fire risk assessment, these provisions may be made by the FRS, the emergency response team (where available) or occupational fire brigade (where available), and may be supplemented by resources available from mutual aid assistance schemes or contract emergency response service providers. Where provided, emergency response team members or occupational fire fighters should be issued individually with, and trained in the use of, the necessary ensemble of PPE certified to relevant national or European standards, and selected following a risk assessment.

Installation managers should discuss their main attack fire-fighting needs with the FRS before finalising their own provisions. Whilst PPE, clothing and equipment should have distinguishing features, it is particularly important to ensure compatibility of:
- fire hose and fire hydrant couplings;
- foam supplies and foam making equipment;
- communications equipment.

Checks should be made to ensure that the site drainage facilities are adequate to avoid flooding by fire-fighting water. In addition, the emergency plan should identify how it will manage the potentially large quantities of fire-fighting water that may be produced (see section 5.5).

4.6 INSPECTION, TESTING AND MAINTENANCE

At all sites and where used on mobile facilities, fire extinguishers should be subject to scheduled examination, testing and maintenance procedures. This should include routine discharge and refill of the extinguishing media. Records of inspection, testing and maintenance should be kept and the date of the last successful inspection marked on the extinguisher. Some form of seal, which has to be broken on discharge, should be fitted to each fire extinguisher when it is reconditioned to help identify extinguishers in need of maintenance.

At larger sites, fire-fighting equipment and PPE should be available for immediate use in the event of an outbreak of fire. It should be maintained in full working order and restored to this condition as soon as possible after use.

Fixed fire-fighting equipment should be inspected and tested by a competent inspector at regular intervals (not exceeding six months). The results of such inspections and tests should be entered in a register and necessary repairs carried out.

PPE should be inspected immediately after use in an incident or training exercise and serviced as required. Where applicable, regular inspections should be conducted of:
- engineering control measures (e.g. secondary containment (e.g. bund) integrity, emergency isolation valves, etc.);
- stock storage and control (e.g. segregation of incompatible stock);
- LPG storage and use.
5

ENVIRONMENTAL PROTECTION

5.1 INTRODUCTION

This section provides guidance on the environmental hazards associated with bitumen and the structural measures, related legislation and systems of work that should be considered to protect against these.

The main environmental hazards related to bitumen are associated with atmospheric discharges and the impact on the water environment of loss of containment from manufacture, storage, transport or handling and use, particularly of cutback bitumen or emulsions.

5.1.1 Air pollution

The key emissions from bitumen processes that warrant control are bitumen fume, odour, PAHs, hydrogen sulphide, volatile organic compounds, and particulate matter. In addition, there will be tar fume emissions where coal tar is added to bitumen products; however, as noted in section 1.1, such products are out of the scope of this Code.

Delivering, storing, heating, mixing and cooling bitumen may give rise to bitumen fume, PAHs and odour. Storage and delivery of solvents and blending them with hot materials may give rise to volatile organic compounds and odour. The process of oxidising bitumen may give rise to hydrogen sulphide, bitumen fume, PAHs and odour. Particulate matter can arise from drying, handling, bagging, loading and unloading limestone and other solids and from the transfer of potentially dusty materials, including their discharge into hoppers and onto conveyors, and delivery to storage silos, although such emissions are outside the scope of this Code.

5.1.2 Water pollution

Because of the vis cose nature of paving, hard and oxidised bitumens, it is extremely unlikely that they could cause water pollution as a result of failures of storage systems. Cutback bitumens and emulsions have the potential to cause serious environmental harm if they reach a watercourse or ground water. In most cases, hydrocarbons will form a layer at the surface of any water body. However, emulsions, by their nature, incorporate a range of additional emulsification agents, acids and bases that are harmful in the aquatic environment and will emulsify the bitumen, distributing it throughout the water body and increasing the potential hazard. Bitumen emulsions also have the potential to cause pollution in use, due to the polluting nature of the water remaining when the emulsion has 'broken'.

5.2 PREVENTING AIR POLLUTION

Most processes involving the heating of bitumen at fixed sites are regulated under Local Air Pollution Control (LAPC) established by Part I of the Environmental Protection Act 1990 or Local Air Pollution Prevention and Control (LAPPC) established by the Pollution Prevention and Control Act 1999. In England and Scotland, tar and bitumen processes have transferred from regulation under the 1990 Act to the 1999 Act. These processes include mastic asphalt production, manufacture of RBM, blowing of bitumen, impregnation of refractories with pitch, production of waterproof paints that contain bitumen, manufacture of carpet containing bitumen, manufacture of packaging
products containing bitumen and manufacture of acoustic panels for road vehicles and domestic appliances.

Statutory guidance to regulators under the Pollution Prevention and Control (England and Wales) Regulations provides guidance on appropriate emission control techniques: DEFRA Bitumen and tars processes constitutes statutory guidance to regulators under the 1990 Act, and is being revised by the Environment Agency.

Roadstone coating operations (see section 10.7.1) are the subject of specific guidance under LAPPC: see DEFRA Roadstone coating. The use of bitumen and tar in surface dressing or other construction applications, such as roofing, is not a prescribed process. Manufacturing processes involving the distillation of tars and bitumen are regulated by the environment agencies as Part A processes and separate guidance is available.

In addition to technical information on abatement and control techniques, the process guidance documents emphasise the role of good management in protecting the environment. The following should be in place:

— proper management, supervision and training for process operatives;
— proper use of equipment;
— effective preventative maintenance on plant and equipment concerned with the control of emissions to air;
— ensuring that spares and consumables are available at short notice in order to rectify breakdowns rapidly.

5.3 PREVENTING WATER POLLUTION - STORAGE

The provision of some form of secondary containment for most hydrocarbons is widely regarded as best practice. The Control of Pollution (Oil Storage) (England) Regulations require secondary containment (such as bunding) for hydrocarbons stored at industrial, commercial and institutional sites in England. Similar regulations are in preparation in Scotland. Although the secondary containment of storage tanks containing bitumens that are, in effect, solid at ambient temperatures, does not provide any additional protection to the environment and may, in some circumstances, make clearing up following a spill difficult, there is no specific exemption in the English regulations for bitumen. However, DEFRA and the Environment Agency accept that, for all practical purposes, bitumen storage facilities (for products that solidify at ambient temperatures) do not come under the requirements of the regulations. The Environment Agency have incorporated this into the Oil Storage Regulations Frequently Asked Questions on their web site (http://www.environment-agency.gov.uk/osr) and informed their staff accordingly.

There are a number of exemptions from these regulations, such as the refining and storage of hydrocarbon products for onward distribution. In the case of distribution installations, operators should comply with IP Environmental guidelines for petroleum distribution installations. The storage of hydrocarbons within buildings is also exempt in England (although not in the proposed regulations for Scotland).

The storage in England of all other bitumen-based products, which are liquid at ambient temperatures, and heating oils used to heat bulk bitumen should be in accordance with the requirements of the Control of Pollution (Oil Storage) (England) Regulations. These regulations require secondary containment for all containers used for storing hydrocarbons with a capacity of greater than 200 L. In practice, drums must be stored on drip trays with a capacity of 25% of the drum, whilst larger containers should be provided with secondary containment, typically in the form of an impervious bund, with a capacity of not less than 110% of the volume of the storage tank. Where there are multiple tanks, the capacity of the bund should be a minimum of 110% of the volume of the largest tank. The environment agencies’ Above-ground oil storage provides detailed guidance on bunding. In addition, see DEFRA Guidance note for the Control of Pollution Oil Storage (England) Regulations 2001.

5.4 PREVENTING WATER POLLUTION - DELIVERY, HANDLING AND USE

The protection of the water environment from the risk of a spill during delivery, handling and use should be taken into account in operating procedures. This is of particular importance with cutback bitumens and emulsions. Operatives should be trained to understand the potential threat to the environment and safe pollution prevention techniques in the event of a spill. A simple spill kit should be provided for sites where there are regular deliveries and for road tankers (see section 10.2.1.4). For example a drain blocker could be very useful, even in the event of a spill of bitumen, as this might otherwise flow into a drain and block it.
5.5 DEALING WITH SPILLS

The risk of pollution from spills should be considered and a pollution incident response plan should be developed. The environment agencies’ Pollution incident response planning provides a simple template for such a plan: it identifies why a plan is needed, the key information required and the importance of understanding local drainage. The guidance emphasises that personnel should be trained to understand the environmental hazards and how to deal with such incidents. In accordance with DSEAR, response planning should also take account of the protection of people from the health and safety hazards of spilt products. Further guidance on methodologies to remediate incidents is set out in IP Inland waters oil spill response, whereas response planning for road tanker incidents is provided in IP Code of practice for the development of a response plan for significant incidents involving petroleum road tankers.

5.5.1 Spill kits

Appropriate materials should be kept on site to deal with spills. Instruction notices, appropriate equipment and materials (such as shovels, sand, absorbent materials and drain bungs) should be located at accessible, key locations. Rapid action to contain and limit the spread of spills may make the difference between an unfortunate accident and a serious pollution incident that could result in prosecution.

5.5.2 Contacting the environment agencies

In the event of a spill occurring, the local environment agency should be contacted promptly. In the UK, the three agencies (Environment Agency for England and Wales, Scottish Environment Protection Agency and the Northern Ireland Environment and Heritage Service) share a common incident reporting hotline (telephone 0800 807060). Early notification can save considerable difficulty in the event of a serious pollution incident, ensuring that expert advice on dealing with spills is available promptly and that appropriate steps are taken to limit the impact and notify downstream water users.

5.6 MANAGING FIRE-FIGHTING WATER

Given the fire risk associated with bitumens, careful consideration should be given to the management of water in the event that fire-fighting operations are required. The environment agencies’ Managing fire water and major spillages contains detailed guidance on the need for containing fire-fighting water and the range of techniques that can be used, such as secondary containment in the form of bunds, lagoons and tanks. The emergency plan should include details relating to the management of fire-fighting water and prevention of pollution (see sections 4.2.2 and 4.5.2).
6 MANUFACTURE

6.1 INTRODUCTION

This section deals with only the special features to safeguard against the hazards of bitumen during its manufacture by distillation or oxidation, including its receipt into rundown tankage. The following general issues regarding petroleum processing units should be considered, such as:

— regulatory approvals;
— design;
— layout (separation distances of storage, process plant, occupied buildings);
— operation;
— maintenance and inspection;
— worker competence;
— closure, decommissioning, and demolition.

Operators of manufacturing plants should refer also to the generic health, safety and environmental guidance set out in Sections 2, 3, 4, and 5. In addition, they should refer to Section 7 for guidance on cutback bitumen blending, Section 8 for guidance on fixed storage installations, and Section 11 for guidance on sampling.

6.2 DISTILLATION PLANTS

6.2.1 Process summary

Bitumen to meet the specifications for the paving and hard paving grade classes can be produced as a residue by distillation of the more volatile components from crude oils and crude oil residues. The distillation is usually carried out under vacuum, normally using stripping steam to the column base to promote the removal of the volatile components.

The process is controlled primarily to meet product specifications for penetration value and change of properties after short-term ageing. Dependent upon crude characteristics it may be necessary to apply a mild air rectification step in blowing plant to adjust the penetration/softening point relationship to the desired final specification values.

The temperature of the bitumen leaving the base of the distillation column, depending upon the feedstock type and the product penetration value required, is usually in the region of 350-400 °C.

6.2.2 Rundown temperature control

Before rundown to storage, the product should be cooled to a safe storage temperature (see 6.4 and annex B.2). Cooling is normally achieved by heat exchange against the incoming plant feedstock.

6.3 OXIDATION PLANTS

6.3.1 Process summary

Oxidised bitumens are produced by controlled reaction of residual bitumens and other heavy oil fractions (blowing fluxes) with air, at temperatures that can exceed 280 °C. The reaction is achieved by blowing the air through the bitumen or bitumen/flux mixture in a cylindrical column at atmospheric pressure. This may be carried out as a batch or continuous process.
The blowing flux is selected and the process conditions are controlled within safety constraints to meet product specifications, particularly penetration value, softening point and loss on heating. Guidance on these safety issues is provided in the following sections.

6.3.2 Main hazards associated with oxidation process

The main hazards associated with the oxidation process are:

— runaway reaction due to the exothermic nature of the process;
— explosion in the upper vapour section of the oxidiser vessel;
— froth-over due to introduction of water, either in the feedstock or in the air supply;
— overfilling of the oxidiser vessel with inadequate settling volume;
— explosion in the compressed air supply system due to lubricating oil carry-over and auto-ignition at the temperature of the air inlet system.

These hazards can arise with both batch and continuous oxidation processes. However, the necessary precautions are outlined with reference to a continuous plant.

6.3.3 Typical layout of a continuous oxidation system

Oxidiser vessels are typically vertical with feed entry near the mid-point, an air injection distribution system near the base, quench water nozzles and steam injection point at the top and an overhead vapour disposal line leading to an incinerator (typically in the preheater). The air supply comes from either a separate compressor unit or the refinery air supply; in either case an efficient knock-out system is necessary close to the air entry point, such that both lubricating oil carry-over and water are removed, and there should be no process piping dead legs or low points.

The main reaction is dehydrogenation, with the formation of water vapour, carbon dioxide and some light hydrocarbons. Thus top quench water sprays can be used, together with internal cooling coils in the vessel, to control the temperature rise. The purpose of the steam quench line is to ensure that the oxygen content in the oxidiser ullage space and overhead disposal line does not exceed 15% by volume, based on inlet air assuming no oxygen consumption. In addition, an effective explosion-relief system should be provided.

6.3.4 Process temperature control

The oxidation process is exothermic. The temperature in the blowing column can be controlled by internal cooling coils in the liquid and by the injection of water or steam into the ullage space. Thermocouples for temperature indicators and/or recorders should be located at several points at different heights in the vessel.

In order to limit the risk of frothing within the blowing column, any injection of water should be as fine spray and steam supply lines should have efficient trapping facilities for the removal of any condensate that might be present.

Two completely independent temperature monitoring systems should be provided; one for control of the blowing process and the other to initiate emergency action in the event of high temperature or a rapid rise of temperature. There should be regular checks to ensure the continuing reliable operation of such instruments.

Where intermittent water spray is used, it will be necessary to prevent the spray nozzles becoming blocked with bitumen. The design of the sprays should be such that large slugs of water (which would initiate frothing) cannot be introduced into the oxidiser; a restriction orifice or similar limitation should be incorporated.

In addition to the above there should be a high discharge temperature setting on the compressed air supply of 180 °C maximum.

6.3.5 Process level control

To allow for the turbulent aeration of the bitumen that occurs in the blowing column and the risk of frothing that can arise from the accidental admission of water, a large ullage space should be maintained.

Two completely independent level monitoring systems should be provided; one for direct control of the operating level and the other at a point above the normal high liquid level to initiate emergency action in the event of a high liquid level. A radioactive source/receiver of the gamma switch type should be used for this purpose. There should be regular checks to ensure the continuing reliable operation of such instruments.

6.3.6 Off-gas composition control

In order to minimise risks of explosion in the ullage space of the blowing column and in the off-gas disposal
system, the composition of the off-gas should be kept outside the flammable range, by sizing the top steam injection point to dilute the oxygen in the ullage space to a maximum of 15 % by volume (see above). No special distribution arrangement is needed for this, other than an effective drain system to ensure that the steam line is completely free of water.

6.3.7 Off-gas disposal

Managerial and technical arrangements should be made for the safe and environmentally acceptable disposal of the exhaust blowing air that carries malodorous products from the oxidation process (see section 5.2).

The off-gas handling system should incorporate liquid knock-out, flame arrestor to prevent flashback to the oxidiser, which should be as close to the incinerator as possible, and incineration facilities. The incinerator could be the unit’s preheater itself or an adjacent heater and should have protective devices including flame failure detectors and a low firebox temperature alarm to ensure that the off-gases are properly combusted.

A steam sniffing injection point into the vapour line may be provided. Oil carry-over may not always be completely removed in the off-gas disposal knock-out drum and provision should be made for regular cleaning of the flame arrestors in the off-gas line as often as necessary. The backpressure should be measured upstream of the flame arrestors.

6.3.8 Pressure/explosion relief

The blowing vessel should be provided with a bursting disc or pressure relief system (e.g. buckling pin relief valve) in the upper part, sufficient to release the contents in the event of a froth-over due to water ingress or a runaway oxidation reaction or explosion.

The pressure/explosion relief device should be:
— effective at the low pressure used;
— vapour tight during normal operation;
— self-closing after explosion relief.

Designers should be aware that operation of the relieving system could eject hot bitumen in the event of water entering the vessel or of explosion, and ensure that no essential manually operated equipment, or personnel access routes etc. are located near the oxidiser. Any hot bitumen should be diverted to a blow-off pot.

6.3.9 Process start-up

The most critical period will be during start-up, and a thorough check for the absence of water in the various sections of the plant, including the air supply system, should be carried out. This should include checking that steam jackets on compressors and pumps are not leaking water into the process system, and that the absence of water from a drain valve is not a result of that point having become blocked.

Personnel should not be permitted on the oxidising column or beneath it during start-up; steady state conditions should be awaited. Critical valves on air, top steam and water spray injection should be operated remotely during the start-up or in emergency.

6.3.10 Introduction of bitumen feed

The bitumen feed should be introduced with caution (particularly if the flux component has been stored at a temperature below the boiling point of water), so that if hot bitumen encounters water anywhere in the system it will boil off while the level is still low. This allows more ullage space for the bitumen/steam to disengage without serious froth-over that would activate the pressure/explosion relief device.

Filling can then proceed to the normal operating level, using either measurement by displacement meter, or the level monitoring system (see 6.3.5) to avoid overfilling that could cause carry-over through the pressure/explosion relief device on introduction of the oxidising air.

Similar precautions will apply in the filling of a batch blowing vessel.

6.3.11 Introduction of top steam and oxidising air

Before air blowing is commenced, the bitumen in the oxidiser vessel should be at a minimum temperature of about 220 °C, since below that temperature, the oxidation reaction will be too slow. In some cases feed will already be at such a temperature; in other cases it will be brought to that temperature by the preheater, or by circulation through heat exchange.

Before air is introduced, the ullage space should be made inert by injection of top steam; otherwise, the presence of air and flammables near their ignition temperature may explode. This steam rate should be continued during the start-up period, controlling the dilution of oxygen to 15 % by volume, and is applicable to both vertical batch and continuous units. This dilution narrows the flammability limits of any oxygen-flammable mixture that forms, and also compensates for the lower consumption of oxygen when air is first injected and until normal operating temperatures are reached.

Air should not be introduced until the bitumen is substantially above the air injection point (typically
5 m) and, after the temperature has reached 220 °C or higher, and oxidation is under way, top steam may be reduced. However, during upsets or loss of temperature, steam should be increased to bring the oxygen level back down to 15 % by volume or less.

When air is cut off at the end of the run, top steam should be applied sufficient to ensure again that the ullage space is purged and its contents displaced as the unit is pumped out.

6.3.12 Process duration

The required blowing time in the continuous oxidation process will be a function of oxidation vessel size, feed rate and composition, and blowing temperature. A maximum operating temperature is generally regarded as being 290 °C.

6.3.13 Process temperature control

Cooling can be by reducing feed inlet temperature, by internal cooling coils within the oxidiser vessel, or by circulation through an external cooling system. Should it not be possible to control temperature by these means, the spray water system may be applied to the surface of the bitumen, so that the vaporisation of the droplets cools the contents of the oxidiser. An alternative control procedure may be to reduce or shut off the oxidising air while maintaining the other means of cooling.

If the oxidising air is shut off, cooling with water spray cannot be safely used, since the loss of the air/bitumen turbulence may result in localised surface bitumen solidification and the accumulation of water, which could be dangerous. In such a situation, the water spray and oxidising air should both be shut off, with top steam on until the vessel content cools to a safe temperature by normal heat loss.

6.3.14 Reduced throughput

If reduced capacity is required, this should not be achieved by reducing oxidation vessel liquid level; this would adversely reduce the required contact time for oxidation, and result in increased oxygen content in the vapour section of the vessel, that may not be adequately purged by the top steam.

Maintaining the full normal liquid level, but using a reduced air blowing rate should achieve reduced throughput. This will only be successful if the air distribution can be maintained effectively at the lower rate; poor air distribution can result in the air partially bypassing the bitumen by channelling to the ullage space, resulting not only in incomplete blowing of the product but also in a high oxygen content in the ullage space which may constitute a hazard.

Some air distribution designs, e.g. of the internal 'spider' type, afford little or no flexibility in this respect. However, if external injectors are used, it may be possible to proportionately shut down a number of these to match the desired air flow rate reduction. In such a case, it should be ensured that a mal-distribution of air does not result and that at least 50 % of the external injectors are used, and that no two adjacent nozzles are shut off.

6.3.15 Rundown temperature control

Before rundown to storage, the product should be cooled to a safe storage temperature. For oxidised bitumen, depending upon the product grade, the temperature chosen will depend upon whether or not the rundown tank is to be inert gas blanketed. See 6.4.1.2.

6.4 RUNDOWN TANKAGE

The term 'rundown tank' is used to distinguish between tanks connected directly to receive newly produced product from the manufacturing plant, and other tanks with no such connection that are involved in the subsequent transfer through the distribution chain to the eventual storage by the bulk user.

Rundown tankage has many requirements in design and operation etc. in common with other bitumen tankage; see Section 8. This section sets out the additional requirements either for all rundown tankage operations or for those of a particular type, such as the oxidised grades.

Factors that are common to all rundown situations are described, taking into account the possible formation and ignition of flammable atmospheres (see Section 3). In addition, guidance is provided depending upon whether the bitumen product is distilled or oxidised.

6.4.1 Avoidance of flammable atmospheres - general

Flammable atmospheres should be avoided in the ullage spaces of bitumen rundown tanks at all stages of operation because pyrophoric deposits can be present and the conditions can occur under which self-heating might take place.

Whilst the storage temperature maxima given in annex B.2 normally provide a reasonable margin of safety against the formation of flammable atmospheres in finished product distribution and user storage tanks, there are additional factors in manufacturing processes that make it difficult always to avoid the temperatures
and product compositions that might produce flammable conditions in rundown tanks.

Common to all grades there are the risks that in manufacturing:

- The bitumen contains more volatile components than expected, e.g. due to insufficient stripping steam.
- The bitumen is contaminated with volatile substances due to a fault with a heat exchanger.
- The bitumen runs down for a time at an excessive temperature.

Protective measures should therefore be incorporated into design and operating procedures to minimise these risks. These should include wherever possible a positive pressure differential between the two sides of heat exchange facilities such that if a loss of containment occurs it will be from the bitumen side to the volatile side rather than the converse.

Where water cooling is applied to a rundown stream, the pressure on the bitumen side should be greater than on the water side to avoid water ingress and possible serious froth-over in the rundown tank. The use of air-fin coolers can avoid this water contamination potential, but there is a risk of plugging at low throughput. See also section 8.3.9.

The unplugging of heat exchanger or cooler tubes or piping should be treated with great care.

A general control measure in manufacturing should be to ensure the continuing integrity of safety-related control or protection systems. See section 3.4.1.

The following further provisions will depend upon whether the bitumen concerned is distilled or oxidised.

6.4.1.1 Distillation plant bitumen rundown tanks
Whilst small amounts of volatile hydrocarbons, probably arising from thermal decomposition downstream of the distillation plant (see section 3.3.2), are often detectable in the ullage spaces of distillation plant bitumen rundown tanks, these are not normally sufficient to produce flammable atmospheres in the tank ullage space provided that the rundown temperatures do not exceed the maxima set out in annex B.2.

It is not normally necessary therefore, in the case of distillation plant bitumen rundown tanks, to provide for continuous displacement of flammable atmospheres. As a safeguard, however, against product contamination by volatile materials or excessive rundown temperatures, provisions should be made for occasional purging with steam or inert gas.

Continuous purging of ullage spaces with steam or inert gas is undesirable because it can promote the development of pyrophoric deposits and unless special provisions are made to dispose of the continuously vented vapours, these can lead to environmental nuisance (see section 5.2).

6.4.1.2 Oxidation plant bitumen rundown tanks
Flammable atmospheres can be detected in some oxidation plant bitumen rundown tanks at temperatures below the maxima set out in annex B.2. These could be due to the greater potential of freshly blown bitumens, compared to other grades, to evolve flammable vapours (see section 3.3.2.2) (a reactivity that declines with time, similar to the decline after transfer to subsequent tankage), rather than to the carry-over of unstripped light material from the blowing process or from heat exchanger leakage.

Some deposits taken from the ullage space of oxidised grade rundown tanks can become incandescent when heated in air below their storage temperatures. However, deposits from tankage on other grades and on downstream oxidised grade tanks have shown no such activity at temperatures below 250 °C.

For this reason, and to provide an appropriate margin of safety, controlled oxygen depletion should be applied to the ullage spaces of any oxidation plant bitumen rundown tanks likely to be operated at temperatures in excess of 200 °C. For guidance on how oxygen depletion control should be applied, see section 8.3.8.

For oxidation plant bitumen rundown tanks not likely to be operated at temperatures above 200 °C provision should be made for occasional purging with steam or inert gas.

6.4.2 Avoidance of source of ignition - General
It is not possible to avoid completely the formation of pyrophoric deposits in manufacturing plant rundown tanks. In order to minimise their rate of formation, product temperatures should be kept as low as practicable, all other factors being considered.

Process rundown pipes therefore should not pass through rundown tank ullage spaces unless specially insulated, both because such pipes can promote the accumulation of carbonaceous deposits and because they might occasionally become excessively hot, causing ignition.
7

BLENDING

7.1 INTRODUCTION

This section provides guidance on blending processes that are used to produce other bitumen grades.

Operators of blending installations should refer also to the generic health, safety and environmental guidance set out in Sections 2, 3, 4, and 5. They should also refer to Section 8 for guidance in respect of the design, construction, operation, inspection and maintenance of fixed installations for the storage of bitumens and cutback diluents.

7.2 PROCESS OVERVIEW

Some paving grade bitumens can be produced directly by distillation to grade from suitable crudes, but most grades of bitumen are produced by the blending of two or more 'base grade' components to achieve the required product specification. Cutback bitumens are produced as described in section 1.2.5 by blending paving grades with lower viscosity, volatile diluents such as kerosine.

The various blending methods used can be categorised either as batch blending or as in-line blending.

Blending entails the bringing together of streams with different temperatures and different physical properties. Therefore, the systems, including pipelines, manifolds and valves, should be designed and operated so that as far as practicable, streams cannot be accidentally mixed or routed to wrong destinations and water cannot be introduced. Where misrouting is possible, unused connections should be positively isolated and the process lines should be carefully checked before any blending operation. During the blending operation, strict procedural control should be exercised. This applies particularly in cutback bitumen blending where volatile diluents are involved.

7.3 BATCH BLENDING

7.3.1 General

In this method, predetermined batches of the blending components are transferred either separately or simultaneously into the blending/storage tank, where they are mixed until homogeneous.

Blending in the tank should be by pumped circulation through a submerged jet nozzle or by using mechanical mixers inside the tank. Air injection should not be used for mixing bitumens, as it will change its properties.

If jet nozzles are applied inside the tank, they should only be operated when sufficiently submerged to avoid a jet of liquid splashing upwards from the surface.

Propeller type mixers in the tank should only be operated when the blades are covered by a level of bitumen sufficient to avoid entrainment of air.

Personnel should not go on to the tank roof during blending/circulation. If access is necessary, the mixing/circulation should be temporarily stopped (see section 8.4.6).

7.3.2 Cutback bitumens

During batch blending to produce cutback bitumen, the volatile nature of the diluent often causes the ullage...
space of the blending tank to pass through the flammable range. Consequently, flammable vapour is often discharged from vents to the atmosphere around the tank.

Pressure/vacuum relief valves or flame arrestors are not normally used in such tank vents because of the problems of fouling. It is therefore particularly important to avoid all sources of ignition near cutback bitumen tank vents because any ignition might be transmitted to the tank ullage space. See area classification in section 8.2.2.3 and Annex C.

Cutback bitumen blending should generally be carried out only in tanks designated for that operation and safeguarded in accordance with the guidance of Section 8. Care should be taken to ensure that any water that may have accumulated in the diluent handling system does not pass through to the blending operation. See sections 8.3.9 and 8.4.5.

Batch blending of cutback bitumen should be discontinued during electric storms.

Cutback bitumen blending requires close control of the temperature of the bitumen component. This should be as low as practicable to minimise the loss of vapour and the risk of fire or explosion.

During blending, the diluent should be added to the bitumen, preferably by injection into a circulation stream entering the tank below the liquid surface. If the diluent is to be added directly to the blending tank, it should be injected well below the liquid surface in the tank and arrangements should be made to provide adequate initial mixing at the point of entry in order to avoid undue vapour generation that could overwhelm the venting capacity.

### 7.4 IN-LINE BLENDING

With in-line blending two or more components are simultaneously pumped into a single pipeline under ratio control such that the mixed product meets the required specification.

Bitumens and cutback bitumens produced in this way can be discharged to either site tankage or direct to a ship, road tanker or rail wagon.

There are no particular hazards with in-line blending other than those related to the handling and storage of bitumen in general, provided that reliable controls of the component temperatures, properties, blend ratios and the subsequent mixing within the pipeline are ensured. In the case of blending of cutback bitumens, particular care is required to ensure that volatile diluent cannot pass, either unmixed or in the wrong proportions, through the system. Instrumentation should include a logic system to isolate all the flows in the event that flow of any components stops.
8

STORAGE

8.1 INTRODUCTION

General issues regarding planning, layout, tank compounds and compound walls, buildings, staffing, competence, closure, decommissioning and demolition are given in IP Design, construction and operation of petroleum distribution installations. In addition, site layout needs to account for access for fire fighting (see section 4.2). General guidance on environmental protection is given in IP Environmental guidelines for petroleum distribution installations.

This section provides guidance for safety and environmental protection in the design, construction, operation, inspection and maintenance of fixed installations for the storage of bitumens, cutback bitumens and cutback diluents. Typically, such storage tanks will comprise a vertical cylindrical shell with a conical roof that is self-draining. At fixed bitumen user installations, hot bitumens are usually stored in insulated horizontal cylindrical or rectangular tanks.

Operators of storage installations should refer to the generic health, safety and environmental guidance set out in Sections 2, 3, 4, and 5. In addition, they should refer to Section 7 for guidance on cutback bitumen blending, Section 9 for guidance on loading from distribution installations, Section 10 for guidance on unloading at customer storage facilities, and Section 11 for guidance on sampling.

8.2 GROUPING, SPACING, SECONDARY CONTAINMENT AND AREA CLASSIFICATION OF TANKS

The distinction made in section 3.3 between Unclassified bitumens (i.e. paving, hard and oxidised bitumens) and those in Class II(2) or Class III(2) (i.e. cutback bitumens), affects the grouping, spacing and secondary containment of tanks and the area classification of tankage areas. In addition, distinctions in area classification are made for Unclassified bitumens depending on whether the storage tanks are for bulk distribution and use or for process rundown operations.

Where there is any doubt over the product class of the bitumen to be handled, installations should be located, arranged and designed as for Class II(2) products.

Guidance on hazardous area zone dimensions is based on generic installations in an open area (i.e. where flammable gases or vapours are readily dispersed by wind) at a maximum ambient temperature of 30 °C. Where the installation under consideration differs from these criteria, refer to IP Area classification code for installations handling flammable fluids.

8.2.1 Bitumens other than cutback grades (Unclassified products)

The following sections describe the facilities necessary for tanks that may contain paving, hard and oxidised grade bitumens, which are Unclassified products (see annex A.3).

8.2.1.1 Grouping and spacing

No particular minimum distances are recommended for the spacing of tanks containing these Unclassified products. Tanks should be arranged and spaced to suit constructional and operational needs whilst providing adequate access for mobile fire fighting equipment (see section 4.2).

They should normally be located at least 6 m from...
any public boundary or occupied workplace (e.g. offices) but at a greater distance if necessary to avoid any risk of tank spills or froth-over reaching there. See 8.2.5 for guidance where Class 0 or Class I products are also present in adjacent facilities.

8.2.1.2 Secondary containment

Secondary containment (such as bunding) is not mandatory for these Unclassified products but low diversionary walls or ditches should normally be provided to stop spillages from reaching operating areas, public boundaries and areas required for firefighting access. However, the absence of secondary containment will mean that careful consideration should be given in emergency plans to both potential flow paths for burning bitumen and management of firefighting water (see sections 4.2.1, 4.2.2 and 5.6).

8.2.1.3 Area Classification

Because of the possibility described in section 3.3.2.2, that in the confined space of tanks holding heated Unclassified bitumens flammable vapours could be evolved as a result of localised overheating, tanks for paving, hard and oxidised grade bitumens in the bulk distribution and user sectors should be classified Zone 0 within their ullage space, with a Zone 1 area of hazard radius 1.5 m surrounding top vents and other high level tank openings and a nominal Zone 1 area of hazard radius 3 m surrounding ground level vents (due to impaired ventilation and ground effects). See Figure 8.1.

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**Figure 8.1 - Generic area classification for Unclassified bitumens stored in cone roof tanks in bulk distribution and user sectors**

**Key**
- Zone 0
- Zone 1
- Zone 2

**Notes:**
1. Diagram not to scale.
2. Diagram applies to a generic installation in an open area at a maximum ambient temperature of 30 °C. Where the installation under consideration differs from these criteria, refer to IP Area classification code for installations handling flammable fluids.
3. Diagram applies to filling rates up to 250 m³/h.
4. The area inside the bund (where present) is not a hazardous area for Unclassified bitumens; however, part of it will be a hazardous area where a ground level vent is used.
5. The area inside the pit or depression is not a hazardous area for Unclassified bitumens provided that the hazardous area arising from a ground level vent does not extend above it and there is no internal source of release.
6. In normal operation, there is no Zone 2 hazardous area surrounding the Zone 1 hazardous area to vents or other high level tank openings.
STORAGE

Figure 8.2 - Generic area classification for Unclassified bitumens stored in cone roof tanks for process rundown operations

Key

| Zone 0 | Zone 1 | Zone 2 |

Notes:
1. Diagram not to scale.
2. Diagram applies to a generic installation in an open area at a maximum ambient temperature of 30 °C. Where the installation under consideration differs from these criteria, refer to IP Area classification code for installations handling flammable fluids.
3. Diagram applies to filling rates up to 250 m³/h.
4. The area inside the bund (where present) is not a hazardous area for Unclassified bitumens; however, part of it will be a hazardous area where a ground level vent is used, and that hazardous area may extend to the bund wall. In the absence of a bund, that hazardous area should be assigned a nominal height of 1 m.
5. The area inside the pit or depression is not a hazardous area for Unclassified bitumens provided that the hazardous area arising from a ground level vent does not extend across it and there is no internal source of release.
6. In normal operation there is no Zone 2 hazardous area surrounding the Zone 1 hazardous areas to the vents or other high level tank openings.

Paving, hard and oxidised grade bitumens stored in the confined space of heated process rundown tanks are more likely to contain flammable vapours due to the additional possibility of entraining light hydrocarbons like C3 (propane) and PPA. They should be classified Zone 0 within their ullage space, with a Zone 1 area of hazard radius 3 m surrounding top vents and other high level tank openings and a nominal Zone 1 area of hazard radius 10 m surrounding ground level vents (due to impaired ventilation and ground effects). Where an optional bund wall is present, its height will determine the height of the hazardous area; otherwise, its height is nominally 1 m. See Figure 8.2.

For the bulk distribution and user sectors, and process rundown operations, only electrical and non-electrical equipment with a type of protection meeting the pertinent zoned requirements should be used within the hazardous areas, and all inadequately protected sources of ignition should be avoided (see section 3.4.1).

When designing a storage tank for Unclassified bitumens, whether in the bulk distribution and user sectors, or for process rundown operations, the relative merits of top and lower level vents should be considered by assessing factors such as the possibility of discharging hot product or flammable vapours, the proximity of public boundaries or occupied workplaces (e.g. offices) and the need to locate equipment nearby that may constitute a source of ignition.
Table 8.1 Tank spacing for Class II(2) or III(2) cutback bitumens

<table>
<thead>
<tr>
<th>Description</th>
<th>Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups of small tanks (Note 1)</td>
<td>8 m</td>
</tr>
<tr>
<td>Between a group of small tanks (Note 1) and any tank outside the group</td>
<td>8 m</td>
</tr>
<tr>
<td>Between tanks not part of a group of small tanks (Note 1)</td>
<td>Half the diameter of the larger tank; the</td>
</tr>
<tr>
<td></td>
<td>diameter of the smaller tank; or 15 m,</td>
</tr>
<tr>
<td></td>
<td>whichever is least, but in no case less than</td>
</tr>
<tr>
<td></td>
<td>10 m</td>
</tr>
<tr>
<td>Between a tank and any filling point, filling shed or building</td>
<td>15 m</td>
</tr>
<tr>
<td>Between a tank and the outer boundary of the installation, any</td>
<td>15 m</td>
</tr>
<tr>
<td>designated non-hazardous area, or any fixed source of ignition</td>
<td></td>
</tr>
<tr>
<td>Between a tank and any installation handling a Class 1 product</td>
<td>15 m</td>
</tr>
</tbody>
</table>

Notes:
1 A small tank is any tank smaller than diameter 10 m.

8.2.2 Cutback grades (Class II(2) and Class III(2) products)

The facilities necessary for tanks containing cutback bitumens (Class II(2) or Class III(2) products) should account for the vapours that they vent being flammable.

8.2.2.1 Grouping and spacing

Tanks smaller than 10 m in diameter containing these products may be sited together in groups of combined capacity not exceeding 8,000 m³.

Within such groups, no particular minimum distances are recommended for the spacing of tanks. They should be arranged and spaced to suit constructional and operational needs whilst providing adequate access for mobile fire fighting equipment (see section 4.2).

Minimum distances between such groups and tanks greater than 10 m in diameter are given in Table 8.1. See 8.2.5 for guidance where tanks storing Class 0 or Class I products are nearby.

8.2.2.2 Secondary containment

Tanks containing Class II(2) or III(2) cutback bitumens should be provided with secondary containment with the capacity to contain 110% of the volume of the largest tank in the event of a major loss of containment (see section 5.3). This is typically provided by the use of a bund, although other systems may be used; for example, diversionary walls to direct flow to a dispersion or impounding basin.

Separate walls around each tank are not necessary, but the total capacity of the tanks in any one bunded area should not exceed 60,000 m³.

Bund walls should be of a height sufficient to protect fire fighters and they should be located so that a reasonably close approach for mobile fire-fighting equipment can be made to any tank fire.

The secondary containment will also serve as a means to retain fire-fighting water (see section 5.6).

8.2.2.3 Area Classification

Tanks containing Class II(2) or III(2) cutback bitumens should be considered as sources of flammable vapour.

Areas around such tanks should be classified as illustrated in Figure 8.3. It is not usual to classify the area within the bund walls as a hazardous area. Nevertheless, given the possibility of loss of product to the bund, unprotected sources of ignition (e.g. electrical equipment) should not be located within the bund.

Where the bitumen has been cut back with a diluent more volatile than kerosine, such as naphtha, it should be determined whether under the foreseeable range of storage temperatures the product will still be Class II(2), or would fall into Class I. In the latter case, the area classification should be as in Figure 8.4.

When designing a storage tank for cutback bitumens, the relative merits of top and lower level vents should be considered by assessing factors such as the possibility of discharging hot product or flammable vapours, the proximity of public boundaries or occupied workplaces (e.g. offices) and the need to locate
equipment nearby that may constitute a source of ignition.

8.2.3 Cutback diluents

Kerosine diluent stored prior to blending at temperatures below its flash point is classified Class II(1), and area classification is only required as Zone 0 for the ullage space and a nominal 0.5 m hazard radius Zone 1 area surrounding vents and other roof openings. Grouping and spacing, and secondary containment requirements are described in 8.2.1.1 and 8.2.1.2 respectively.

The flash point classification of other diluents should be established, and if they fall into Class I their area classification should be as in Figure 8.4, and their spacing from other facilities should be as in Table 8.1. Secondary containment of such Class I tankage, typically as a bund, should be provided (see section 5.3).

Further guidance on the area classification of tanks containing such diluents is given in IP Design, construction and operation of petroleum distribution installations.

Figure 8.3 - Generic area classification for Class II(2) or Class III(2) cutback bitumens stored at temperatures above their flash points in cone roof tanks

Key

|   | Zone 0 | Zone 1 | Zone 2 |

Notes:
1. Diagram not to scale.
2. Diagram applies to a generic installation in an open area at a maximum ambient temperature of 30 °C. Where the installation under consideration differs from these criteria, see IP Area classification code for installations handling flammable fluids.
3. The area inside the bund is not a hazardous area for cutback bitumens. See 8.2.2.3.
4. Diagram applies to filling rates up to 250 m³/h.
5. The area inside the pit or depression is not a hazardous area for cutback bitumens provided that the hazardous area arising from any ground level vent does not extend across it.
8.2.4 Heating oils for bulk bitumen installations

A variety of heating oils are used for heating purposes in installations handling bulk bitumen to keep the product in a molten state. Fuels such as industrial distillate grades are stored and handled within the Class II(I) or III(I) criteria, i.e. at temperatures below their flash points. Heating oils are frequently circulated at temperatures above their flash points, i.e. within the Class II(2) or III(2) criteria; even if used below their flash points, flammable atmospheres could still occur by releases from heating systems in the form of mists or sprays. Therefore, hazardous area classification should be applied to the heating systems, including storage tanks, pumps and pipework (see 8.2.4.3).

8.2.4.1 Grouping and spacing

The guidance regarding grouping and spacing given in 8.2.1.1 applies to heating oil storage tanks.

8.2.4.2 Secondary containment

The guidance regarding secondary containment given in 8.2.1.2 applies.

8.2.4.3 Area Classification

The area classification of cone roof storage tanks for heating oils stored below their boiling points is as given in 8.2.3 for Class I cutback diluents.

Heating oil pumping and pipework facilities should be subject to area classification; the point source methodology of IP Area classification code for installations handling flammable fluids should be applied.

8.2.4.4 Heating oils for bulk bitumen installations

Figure 8.4 - Generic area classification for Class I diluents stored in cone roof tanks

Key

| Zone 0 | Zone 1 | Zone 2 |

Notes:

1. Diagram not to scale.
2. Diagram applies to a generic installation in an open area at a maximum ambient temperature of 30 °C. Where the installation under consideration differs from these criteria, see IP Area classification code for installations handling flammable fluids.
3. Diagram applies to all Class I petroleum products in ambient storage for filling rates up to 250 m³/h.
4. In the event of a large loss of containment causing product to reach the bund wall, the hazardous area would extend beyond the bund wall. In such circumstances, any unsuitably protected sources of ignition should be isolated.
   L is the equivalent diameter of spill, which gives rise to a hazard radius (R₁) beyond the bund wall. For: L ≤ 5 m, R₁ = 3 m; L = 5-10 m, R₁ = 7.5 m and, L ≥ 10 m, R₁ = 15 m. Data reproduced from IP Area classification code for installations handling flammable fluids.
5. Vents not shown.
8.2.5 Proximity of bitumen tankage to Class 0 and Class I product facilities

Because of the potential for auto-ignition around lagging, tanks containing bitumens of all classes should not be located in areas classified as hazardous arising from Class 0 or Class I product-handling facilities. For example, such a tank should normally be located at least 15 m from any tank containing a Class I product and not be placed in the same bund as a Class I or Class 0 product tank (see Table 8.1).

8.3 Tank design features common to all classes of bitumen

Tanks should be designed and constructed to conform to the relevant statutory requirements of the country in which they are installed. Mild steel cylindrical tanks should conform to BS EN 14015 or BS 2594. Account should be taken of the in-service parameters of maximum operating temperature and pressure. The exterior of the tank may be covered with insulation to minimise heat losses (see 8.3.10).

8.3.1 Access

Tanks should be provided with facilities that provide operative protection that meets The Work at Height Regulations. This should include roof guardrails and toe-plates, and walkways to give access for any necessary operations or maintenance on the roof. Walkways should be arranged so as to avoid the need for operatives to walk across tank roofs. Tank top walkways should have two access routes from the ground arranged as necessary to avoid any part of the walkway becoming isolated by a tank fire.

8.3.2 Heating facilities

Product storage temperatures are defined in annex B.2. Hot oil, steam or electrical heating elements may be provided in the bottom of a bitumen tank to improve heating and agitation of the bottom layers or as outflow heaters mounted at the tank outflow nozzle. Steam or hot oil coils in tanks should be of the all-welded type, to minimise the possibility of leakage, and pressure tests should be carried out at regular intervals (see 8.5.4).

8.3.2.1 Bulk temperature control

Accurate tank temperature control is essential for safe operations and the tank should be provided with reliable means of temperature measurement (see 8.4.3), preferably incorporating more than one detection point located at sufficient positions to facilitate checks when internal circulation is poor. It is usually necessary to provide for occasional pumped circulation or mechanical stirring of the product, in order to reduce temperature layering within large tanks. (Under poor mixing conditions, tests have shown lower temperatures at the bottom/side areas below the heating element.)

8.3.2.2 Heating element temperature control

Heating element temperature controls are necessary to prevent local overheating, because heat transfer can be severely restricted by the high viscosity of the product, with the development of solid decomposition products around the elements and an ensuing rise of local temperatures to the cracking range. Such controls are particularly important for electrical heating elements.

8.3.2.3 Heating element liquid cover

Heating element facilities should include automatic level shut-off switches and alarms controlled from bitumen level sensors to shut off the heating elements when there is less than 150 mm of liquid cover.

Alternatively, the normal offtake level nozzle should be arranged to be a corresponding height above the top of the heating elements.

Uninsulated feeder pipes to hot oil or steam heating elements should not pass through tank ullage spaces.

8.3.2.4 Reheating bitumen from solid

A single vertical hairpin heating element may be provided in a bitumen tank above the bottom heating elements to provide a pressure relief channel up through the stock of bitumen if it becomes necessary to remelt safely the stock from solid. This will avoid the overstressing and possible failure of the bottom shell courses as remelting causes expansion. Where this is done, the vertical element should be independent of the bottom elements and to avoid overheating in the ullage space care should be taken that it is shut off before the bulk of the stock becomes hot.

8.3.3 Product pipes in ullage spaces

For the reasons stated in section 6.4.2, manufacturing plant rundown pipes should not pass through tank ullage spaces unless specially insulated.

Arrangements should be designed to minimise splash filling (see section 3.4.6) and to provide free entry at any level when the tank contents are cold.

For product transfers, other than rundown streams from manufacturing plants, and where top entry into a tank is necessary to keep the delivery pipe clear in all circumstances, a slotted down-pipe to minimise
splashing should be provided extending throughout the ullage space.

**8.3.4 Level control facilities**

Automatic level indicators and alarms are preferred to manual dipping for routine level control (see 8.4.4). Top-mounted, non-intrusive remote sensing instruments using radar or ultrasonic devices may be considered for continuous level measurement where fouling of level floats is a problem. Alternatively bottom-mounted pressure transmitters are very reliable; an isolation valve can be included for critical maintenance access. High level alarms should be independent of other level sensors.

Manual dipping from the tank top (see Section 11) should be minimised but a dip hatch will normally be required for checking automatic facilities. This should be combined with the sampling hatch (see 8.3.11) and designed to minimise the inflow of air and the outflow of vapour when it is used. A walkway should be provided to give access to the dip hatch to avoid damage to the tank roof insulation. A drip tray should be provided to avoid contamination of roof insulation near the hatch.

With tanks such as oxidised grade rundown tanks that in accordance with section 6.4.1.2 and 8.3.8 are operated under oxygen depleted ullage spaces e.g. by inert gas or steam, the avoidance of manual dipping from the tank top is particularly important for reasons of both safety and operational convenience. In such cases, remote reading gauges should be provided.

**8.3.5 Breather vents**

Pressure/vacuum breather valves should not be used in bitumen storage tanks because of the possibility of sticking in the closed position.

For a bitumen tank that is to be vented to the air, a single, permanently open breather vent should be provided. Multiple vents should be avoided because they allow cross-flow of air in the tank roof space and this can promote self-heating of any pyrophoric deposits present. The vent should be designed to keep the tank pressure within the allowable range under all possible product inflow and outflow conditions using API 2000, or equivalent. The vent should also be designed to:

- Discharge well away from any point where personnel might be harmed by discharge of hot material from overflow or froth-over.
- Prevent ingress of rainwater (see 8.3.9).
- Avoid contamination of tank insulation by any oily condensate discharged from the mouth of the vent.

in order to reduce the risks from auto-ignition near the vent (see section 3.4.4 and 8.3.10).
- Minimise the risk of blockage by fouling. For this reason, vents should not be provided with mesh covers or flame arrestors.
- Facilitate access for regular inspection and vent cleaning (see 8.4.9).

Bitumen tank vent areas should be over-designed by 50% because some fouling is inevitable.

Vent calculations should be reviewed when tanks are allocated to duties for which they were not designed, e.g. for a change of pumping rates into or out of the tank, or of pipe inlet size, or where it is proposed (in consequence of the above guidance that cross-flow should be avoided) to reduce the number of the vents. Failure to do this can result in serious damage to the tank roof, e.g. where overfilling forces bitumen to be expelled through the breather vent line, with consequent partial blockage from congealed material.

**8.3.6 Pressure relief panels**

It is normally impracticable to design breather vents with sufficient capacity to relieve the pressures that can be created by froth-over situations.

Hinged and weighted relief panels or specifically designed access chamber covers are sometimes provided to protect the tank in the event of froth-over or minor explosion. Where these are provided, any access chambers below should be protected from the bitumen that might be discharged.

Alternatively, the conical roofs of vertical cylindrical tanks can be designed with weak fragrable shell-to-roof seams. Such designs can be disproportionately expensive for small tanks (e.g. less than about 15 m diameter).

**8.3.7 Vapour collection systems**

At manufacturing sites, vapour extraction systems may be installed for the collection of vapours from bitumen tank vents, in order to provide emission control (see section 5.2). The vapours collected are either incinerated, partially condensed into knock-out vessels, or scrubbed with a suitable washing medium, before discharge to the atmosphere.

Where vapours are collected from tank vents, a carefully designed, pressure balanced system is necessary to ensure that tanks are not subject to over-pressure or vacuum conditions beyond their design range. The system should avoid producing cross-draughts in bitumen tank ullage spaces (see 8.3.5).
8.3.8 Controlled oxygen depletion facilities

Oxygen depletion facilities fitted to oxidised grade bitumen rundown tanks to avoid flammable atmospheres in tank ullage spaces, should be designed to ensure that there is sufficient oxygen in the ullage space to avoid build-up of pyrophoric deposits. Typically, a minimum of 4 % by volume of oxygen is sufficient to prevent the deposits from becoming potentially hazardous. Depending on the type and source of the inert gas, it may already contain such a level of oxygen; otherwise, air may have to be added under ratio control to the inerting gas flow.

The oxygen concentration should be monitored, preferably by using continuous oxygen measurement instruments, in order to maintain the composition of the ullage space normally between 4 % and 6 % oxygen by volume. There should be control measures to ensure that, in the event of any failure that might cause the oxygen concentration in the ullage space to exceed 8 % by volume, any withdrawal of bitumen from the tank should be discontinued to prevent further air from being drawn in.

Oxygen measuring instruments, when installed within the ullage space of the bitumen tank, are liable to fouling. Therefore, such instruments should be positioned in the inert gas/steam supply line as close as possible to the tank(s).

Due to the continuing slow oxidation process that can occur, the oxygen content in the tank will not always be the same as measured in the inert gas supply line. Therefore, the inert gas supply should maintain a minimum flow to the tank even when the tank level is static. This should also help avoid any fouling of the instruments that might otherwise occur.

Apart from reliable oxygen monitoring, the use of inert gas blanketing of tanks requires a carefully designed and operated system, e.g. on the point of pressure control of the tank(s) concerned. Therefore, specialist advice should be obtained when designing such a facility. Because the standard design pressure/vacuum safety valves should not be used in bitumen storage tank service (due to the risk of sticking in the closed position (see 8.5.2)), a specially designed over-pressure and vacuum protection system should be installed, whenever inert gas blanketing is applied. During operation of the system, it should be regularly inspected and maintained, especially the instrumentation.

Note that the measures set out in 8.3.8 are not normally required in tankage other than oxidised grade rundown tanks. For rundown tanks for distillation plant bitumens, see section 6.4.1.1. For measures to minimise deposits that may become pyrophoric in bulk distribution and user tankage see 8.4.7.

8.3.9 Provisions against water ingress

Facilities connected to bitumen tanks should be designed to minimise the risk of water ingress to the tanks. See also 8.4.5. Closures to tank roof openings should be weather-tight and roofs should be free-draining.

Where steam heating of pipelines is necessary, external steam tracing of lines is preferred to jacketing and to internal steam tracing.

Facilities for supplying cutback diluents for blending with bitumen (see Section 7) should incorporate effective water separation arrangements.

8.3.10 Thermal insulation

Thermal insulation on hot tanks and pipes should be sealed against ingress of water and oily products, including bitumen spills, bitumen tank vent condensate drips and leakage from flanges or side entry mixer glands. Damage to insulation covers should be avoided by provision of platforms wherever access over insulation is necessary.

8.3.11 Sampling arrangements

Sampling preferably should be carried out from a pipeline used in association with the tank or, when good mixing has been assured, from a connection on the tank shell. Sample valves for these purposes should be specially designed (see section 11.4).

Manual sampling from the tank top should be discouraged due to the possible release of hydrogen sulphide but, where necessary, a sample hatch should be provided. This should be combined with the dip hatch. When sampling is required from oxygen-depleted tankage, fixed sampling points should be used in place of dipping (see 8.3.4).

8.3.12 Tank lighting

Tank lighting should be adequate for access requirements during the hours of darkness.

8.3.13 Pipework systems

Pipework systems that might be left full of product between operations should have adequate thermal insulation and trace heating facilities to prevent blockage due to solidification. Where trace heating is provided, special care is necessary to avoid heating
8.4 TANK OPERATIONS

8.4.1 Labelling of equipment

Tanks, pipes and fill valves should be marked independently for identification with a unique number and, if practicable, the product grade in accordance with the IP Code of practice for a product identification system for petroleum products. Additionally, cutback bitumen and cutback diluent tanks should be marked ‘danger flammable’ on their shells and in visible proximity to vents and other tank openings. Marking will help avoid inadvertent mixing of contents and alert personnel and others of the possible presence of a dangerous substance and its vapour.

Tanks that can be operated under any form of oxygen depletion system should have warnings displayed at dip hatches and similar roof apertures to avoid inadvertent opening.

Product and service hose connection points and valves should be labelled to indicate their duties and grades.

8.4.2 Safeguards against hydrogen sulphide

The main inhalation hazard arising from heated bitumen is the formation of lethal concentrations of hydrogen sulphide in the confined ullage spaces of bitumen tanks (see section 2.2.2.2). Exposure measurements taken at >0.3 m from hatch openings have shown dilution to below hazardous levels such that the risk is low when pumping, gauging or sampling tanks. Nevertheless, tank tops, particularly the region around dip holes and tank vents, should be regarded as giving rise to emissions that are potentially hazardous to health. Personnel should be informed of the potential hazard and systems of work should be instituted that avoid their accessing tank tops (see 8.4.6). Where essential, e.g. when opening dip holes or hatch covers, they should position themselves upwind and with their faces at least 0.7 m from the release source.

8.4.3 Tank temperature control

A maximum working temperature should be specified for each tank taking account of the guidance in annex B.2 and, in the case of bitumens other than cutback grades, the need to avoid the occurrence of flammable atmospheres in the tank ullage spaces.

Accurate temperature control is particularly necessary where the bitumen product is to be stored close to the maximum set out in annex B.2. Modified bitumens will require varied storage and handling temperatures whilst being subject to a maximum.

Regular checks are necessary to ensure that automatic instruments are working correctly (see 8.3.2). Where automatic control instruments are not provided, strict procedures are necessary to ensure that bulk temperature limits are not exceeded in any part of the tank and that active heating elements are not uncovered. Readings can be unreliable if taken only near the heating elements, shell or tank bottom.

8.4.4 Tank level control

A maximum safe working level for each tank should be determined (see 8.3.4). A high level alarm should be fitted to each tank and this should allow a margin for thermal expansion of the product in the tank and for eruption and foaming that might result from a small accidental ingress of water.

Before the start of any transfer into a tank, checks should be made to confirm that there is sufficient ullage for the proposed transfer without exceeding the maximum safe working level.

Manual dipping of tanks, other than those with oxygen depletion, will be necessary for occasional checking of automatic facilities and for control of transfers where there are no automatic level measuring instruments. Access to bitumen tank roofs for this or any other purpose should be regulated as described in 8.4.6. Guidance on sampling is provided in Section 11.
8.4.5 Avoidance of froth-over

In order to avoid the risks of froth-over in bitumen tanks, particular care is necessary to:

— Remove water from pipework and other facilities before passing product through them to a tank already containing bitumen.
— Avoid ingress of water through open hatches and inspection covers on the roof of a tank, particularly when fire-fighting or during emergency tank cooling.
— Ensure that all water has been effectively removed from any cutback diluent system before the diluent is passed to a bitumen tank.
— Avoid and make regular checks for leaks in steam coil (see 8.5.4). When a coil is shut down an atmospheric bleed should be opened on the coil near the tank and checked for condensate or signs of product leakage.
— Ensure tank is free of water when being returned to service after cleaning/maintenance.

Tanks should not be operated in a temperature range that fluctuates above and below the boiling point of water, as these fluctuations are conducive to the accumulation and then rapid vaporisation of water, which often results in froth-over. A tank operated continuously above 100 °C has less opportunity for water accumulation by condensation.

If, despite draining, the presence of water is suspected in a tank containing bitumen at a temperature below 100 °C and it is necessary to heat the product, great care should be taken to raise the temperature slowly through the range 95 to 120 °C, in order to avoid froth-over. In these circumstances, use of anti-foaming agents can be beneficial, but access near to or on the tank should be prohibited during this period.

8.4.6 Access to bitumen tank roofs

Access by personnel to hot bitumen tank roofs should be strictly regulated at all times. It should be avoided as far as is reasonably practicable during product movements into or out of the tank concerned, or when mixing or circulating is in process. It should be prohibited:

— during the blending of cutback bitumens (see section 7.3.1);
— during raising of the tank temperature;
— if the tank might contain a flammable atmosphere;
— during any outbreak of fire in the vicinity;
— during periods of high wind;
— during electric storms.

Non-essential personnel should not be near tanks being filled with bitumen to prevent their exposure to the vapours discharged, especially hydrogen sulphide (see 8.4.2). Essential personnel should position themselves upwind of vents and other openings to minimise their exposure.

8.4.7 Control of pyrophoric deposits in bitumen tankage (other than manufacturing rundown tanks) for oxidised grades

The circumstances under which solid carbonaceous deposits on the walls or the roof areas of bitumen tanks can become self-heating are described in section 3.4.5. They are of particular significance where there may be a coincident flammable atmosphere in the ullage space.

The oxidation process that occurs with such deposits can be a slow reaction that normally produces no significant local temperature rise; this is the normal experience with oxidised grade non-rundown tanks, and with rundown and non-rundown tanks for other bitumen grades. However, where deposits are present there is always some risk that self-heating might occur. Tankage may therefore be subdivided according to the likelihood of undergoing self-heating, which in turn depends on the grade and position in the product supply chain:

— Manufacturing rundown tanks from oxidation plants, which should be equipped with the stringent control measure of controlled oxygen depletion facilities (see section 6.4.1.2 and 8.3.8).
— Other rundown tanks from distillation plant, which do not require oxygen depletion, but should be given the less stringent control measure of periodic ventilation (see section 6.4.1.1).
— Other tankage in the bulk distribution and user sectors, which require operational control measures such as use of the lowest practicable bitumen storage temperatures (which also minimises the probability of generating a flammable condition in the ullage space). The guidance given in 8.4.3 and annex B.2 should be followed.

Carbonaceous deposits in non-rundown tankage should be kept in a steady state with their surroundings until they can be removed by thorough tank cleaning. This steady state is promoted by:

— Avoiding through-draughts of fresh air in ullage spaces (see 8.3.5) that can suddenly increase the rate of oxidation that is normally continuously occurring at the surfaces of deposits.
— Avoiding significant step changes in the temperature regime surrounding the tank, e.g.
adding heat insulation across the roof could result in existing roof deposits overheating.

If tankage operating conditions cannot be selected to prevent the build-up of deposits, consideration should be given to removal of the deposits by cleaning before they begin to break away, exposing new surfaces at which self-heating might start.

Note, should specific user requirements require a higher temperature than set out in annex B.2, this should be achieved not by increasing the bulk tank temperature of the bitumen but by reheating the product separately from the tank, e.g. by suction or line heaters. (For the maximum temperature during loading into road tanker or rail wagons, see annex B.4.)

8.4.8 Clearance of pipeline blockages

The design guidance given in 8.3.9 and 8.3.13 should be noted. Unsafe methods of attempting to clear pipeline blockages can give rise to serious accidents due to the heated nature of the product and so should not be permitted. The operational guidance given in section 9.11 should be observed.

8.4.9 Clearance of breather vents

A regular routine of checking that breather vents are unobstructed should be carried out (see 8.5.2).

8.5 INSPECTION

8.5.1 General

External inspection of the exposed parts of tank walls and fittings to detect leaks and other possible defects should be carried out on a routine basis.

The intervals between full internal inspections of tank walls, floors and internal fittings, entailing total emptying and cleaning should be specified in company management systems.

Records should be kept of inspections and necessary maintenance identified.

8.5.2 Breather vents and pressure relief panels

Bitumen tank vents and pressure relief panels (see 8.3.5 and 8.3.6) are particularly susceptible to fouling. A regular inspection schedule should be established from local experience.

Inspection and cleaning of vents should normally be possible without emptying the product from the tank; however, a carefully defined PTW procedure (see section 3.4.2) is necessary in each case to avoid risks of ignition at the vent and to minimise exposure of personnel to fumes, particularly when hydrogen sulphide is present.

8.5.3 Thermal insulation

Areas of thermal insulation likely to be contaminated by oil or bitumen spills should be of a non-absorbent type, sealed, inspected frequently and, to avoid auto-ignition (see section 3.4.4), replaced whenever there are signs of product impregnation or damage to the cladding.

8.5.4 Heating coils

A regular schedule for integrity checks on steam and hot oil heating coils should be established from local experience. This should include coil draining checks with the tank in service and pressure testing of the coil when the tank is out of service.

8.6 MAINTENANCE AND TANK CLEANING

8.6.1 Preparation for entry

Bitumen tanks may have to be taken out of service for purposes such as product change, inspection and maintenance. Decommissioning procedures and their precautions will differ accordingly.

In cases where personnel will have to enter the tank for inspection and/or cleaning purposes, extensive precautions for decommissioning and gas-freeing apply. For detailed guidance, see IP Tank cleaning safety code. In addition, the requirements of the Confined Spaces Regulations and HSE Safe work in confined spaces should be considered.

In the case of bitumen tanks that have been operated under oxygen-depleted atmospheres such as inert gas or steam (see 8.3.8), there may be an increased risk of the presence of pyrophoric carbonaceous and/or iron sulphide deposits. These might become reactive and a potential source of ignition for any flammable vapours in the tank, as well as for the deposits themselves, when the inert gas/air atmosphere is being replaced by fresh air with ambient oxygen content. Where such risk exists, after emptying and cooling-down the tank, the inerted tank atmosphere should not be directly displaced by air.

Methods to displace hydrocarbon vapours can include continued purging by inert gas or steam, or water displacement. In the latter case, care is required to ensure that the tank is not filled to above the maximum
level allowed for by the tank and foundation design. Only after this displacement process has been completed should the tank be isolated from the inert gas supply and opened to the atmosphere to allow air to enter as the water is subsequently slowly drained from the tank.

Whenever water is introduced into tanks extreme care is required to ensure that no water remains in the tank or associated pipework prior to refilling with hot bitumen (see 8.6.6).

### 8.6.2 Entry into bitumen tanks

Tanks that have contained bitumen may, even when cold, contain hydrocarbon vapours and/or hydrogen sulphide, and may also be deficient in oxygen. There should therefore be no entry to personnel, either full body or partially, i.e. head and shoulders, without a PTW procedure (see section 3.4.2) to ensure that all the necessary precautions are taken.

These precautions should include arrangements to ensure that the tank is:

- Drained clear of bitumen as far as practicable.
- Positively isolated from all sources of fluid other than fresh air, by spading or blanking of pipes and ducts and by avoiding discharges of flammable and toxic vapours near tank openings; closed valves, even when locked off and made inoperable, are not acceptable as a safe means of isolation.
- Isolated from all sources of heat and power.
- Cooled throughout as near as reasonably practicable to ambient temperature.
- Ventilated thoroughly with fresh air, by opening upper and lower access chamber covers.
- Tested throughout using gas detectors for gas-free status by a competent person, wearing appropriate PPE (in particular, RPE), for the presence of flammable vapours and hydrogen sulphide and for the adequacy of the oxygen concentration for breathing.

If there are any signs of smouldering within the tank, possibly due to pyrophoric deposits, the area concerned should be damped down with water and kept damp until the deposits can be removed.

Particular care is necessary when entering uncleaned bitumen tanks, to avoid the risks to personnel from falling lumps of bitumen or carbonaceous deposit that may have become detached from the wall or roof during cooling.

The PTW should specify any constraints on the types of tools and lighting that may be used inside the tank due to the possible presence of flammable atmospheres.

#### 8.6.2.1 Entry without breathing apparatus

For entry without SCBA or air-line fed RPE, it should be ensured that:

- Flammable vapours nowhere in the tank exceed 4 % (the target should be zero) of the LFL.
- Hydrogen sulphide nowhere in the tank exceeds 10 ppm.
- Oxygen in the air within the tank is at least 20 % by volume, and that adequate fresh air ventilation is maintained.
- Frequent monitoring is carried out for the presence of flammable or toxic vapours produced by disturbing tank deposits. A tank cannot be regarded as gas-free and safe for hot work in the presence of such deposits (see 8.6.5).
- An attendant is posted at an entry point whenever personnel are inside the tank, and is equipped with the means to raise an alarm.

#### 8.6.2.2 Entry with breathing apparatus

When entry into a tank requires the use of SCBA or air-line fed RPE (see section 2.4.4.1) for reasons of toxicity or oxygen deficiency of the atmosphere, it should be ensured that:

- Flammable vapours nowhere in the tank exceed 25 % of the LFL.
- An attendant is posted at the tank entry point to observe those within the tank. They should be equipped with SCBA and the means to raise an alarm. Use of a lifeline should be considered.
- A second person is responsible for ensuring a satisfactory air supply from the compressor unit to the personnel inside the tank, where air-line fed RPE is used.
- The air compressor supplying air to personnel using air-line fed RPE in the tank is located so that its air intake is in a safe position and remote from engine exhaust or other contamination.
- No work other than inspection is undertaken in the tank.

#### 8.6.2.3 Monitoring of the tank atmosphere

Throughout any period of entry, with or without breathing apparatus, the atmosphere within the tank should be monitored by gas detectors, as necessary, to ensure that it does not deteriorate beyond the limits indicated. Further checks are necessary after every period when the tank has been left unattended.
8.6.3 Tank cleaning

The build-up of carbonaceous deposits around heating coils and in certain wall and roof areas occurs with most grades of bitumen. It usually becomes apparent from changes in the tank working capacity, from difficulties in maintaining tank temperatures, or from difficulties in achieving the required flow of product from the tank. It can be confirmed by visual inspection but this usually necessitates emptying and cooling the tank.

Carbonaceous deposits are most easily removed by draining the tank as far as possible, cooling the remaining contents to ambient temperature and then chipping out, using either mechanical cutting tools or high-pressure water jets. It can help to switch the tank to a high softening point grade immediately before emptying to maximise the brittleness of the material to be removed mechanically.

If personnel entry is required, the tank should be prepared as indicated in 8.6.2.1. PPE, including RPE capable of protecting against dust (see section 2.4.4.1) and approved eye protection (see section 2.4.4) should be worn when chipping bitumen.

When using mechanical tools for chipping there is inevitably some risk of damage to tank coils and fittings. Careful inspection is therefore necessary after cleaning and before further use.

Use of high-pressure water jets is a specialised operation that should only be carried out by competent persons, suitably experienced in the technique and applying all the specialised safeguards necessary.

Carbonaceous and other deposits removed from bitumen tanks, particularly those that have contained hydrogen sulphide, should be kept wet until they can be disposed of to an area where they can be allowed to oxidise freely without risks from any local self-heating that might occur. They can usually be disposed of ultimately to licensed landfill sites.

For general information on tank cleaning, refer to IP Tank cleaning safety code.

8.6.4 Hot work in tankage areas

In support of the control measures set out in section 3.4.2, bitumen tankage areas should be designated an ignition source control area and use of naked flames, spark-producing equipment, etc. should be governed by a PTW.

Before any such work is allowed in tankage areas, the following additional precautions should be taken:

- The work area should be free from any flammable vapours such as might be discharged from tank vents or spills in the vicinity.
- Flammable atmosphere formation in confined spaces resulting from the overheating of carbonaceous materials should be avoided.
- The immediate exterior area around the tank, such as a bund (where present), should be free of combustible material.

Additional fire-fighting equipment, appropriate to the risks, should always be provided near the work while it is in progress (see section 4.4.1).

8.6.5 Hot work on bitumen tanks

Before any hot work (see section 3.4.2) is started inside a bitumen tank, the tank should be prepared as for entry without breathing apparatus (see 8.6.2.1). Additionally it should be ensured that:

- Flammable vapours nowhere in the tank exceed 1 % of the LFL.
- Bitumen and carbonaceous deposits are cleaned away as far as practicable from the hot working location to minimise the risks of vapour production from heating and bitumen ignition.
- Provisions are made to protect against the ignition of any remaining bitumen or carbonaceous deposits not cleaned away.
- Ventilation with fresh air is adequate to clear rapidly any vapours produced.

Note, the flash point of the bulk liquid is not a guide to the presence of a flammable atmosphere in the tank ullage space (see annex A.3); the presence of a flammable atmosphere can be determined by gas testing prior to, and during the hot work.

Similar precautions are necessary before any hot work is started on the outside of a bitumen tank or near any vent from the tank, unless alternative arrangements are made to avoid flammable atmospheres in the tank ullage space for the duration of the work.

8.6.6 Return of tanks to service

Before return of a tank to hot bitumen service, particular care is necessary to ensure that all free water has been removed from the tank bottom and connecting pipework.

After drying out as far as practicable, by draining and mopping up, and before returning the tank to full service, a dryness trial should be carried out by introducing enough bitumen at a temperature not greater
than 90 °C into the tank to cover the coils to a depth of 1 m maximum, and then heating to about 120 °C under temperature control for about 24 hours.
9 DISTRIBUTION

9.1 INTRODUCTION

This section considers the bulk transfer of bitumen by road, rail, ship and barge. Consideration is also given to the handling of packaged bitumen. General guidance on the layout of distribution installations including rail sidings, jetties and wharves is given in IP Design, construction and operation of petroleum distribution installations.

Operators of bitumen distribution installations should refer to the generic health, safety and environmental guidance set out in Sections 2, 3, 4 and 5. In addition, they should refer to Sections 8 and 10 for guidance on the interfaces with bulk storage installations and customer facilities, and Section 11 for guidance on sampling.

9.2 BULK TRANSPORT CONTAINERS

9.2.1 Road tanker tanks

Road tanker tanks intended for gravity, pumped or air or inert gas pressure discharge, should be designed, constructed and tested to BS PD 5500 or equivalent. Tanks should be clearly marked with the maximum working pressure and fitted with relief valves adequate for relief of any possible pneumatic or hydraulic overpressure. It should also be ensured that any requirements under The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations (CDGUTPER) are observed.

Examination, testing and certification of tanks and fittings for the transport of bitumen by road at temperatures in excess of 100 °C are subject to CDGUTPER. They should be certified to 'ADR 1' before they enter service, which requires an MoT test with the certificate being issued under the auspices of the Department for Transport.

An example of a hazard warning panel and secondary hazard warning diamond, which, under these regulations, must be displayed on any road tanker carrying bitumen at a temperature above 100 °C to warn that it is carrying a hot liquid, is given in Figure 9.1. An example of the transport emergency (TREM) card that additionally the driver must carry in the cab is given in Figure 9.2.

9.2.2 Road tanker vehicles

Whilst generic road tanker vehicle design is outside the scope of this Code, road tankers should also have fitted:
- ground operation for all valve equipment;
- handrails;
- brake interlocks;
- emergency secondary safety valve;
- amber beacon visible at all times;
- reversing aids, including:
  - audible warning bleeper (or similar audible warning);
  - rear view camera with a cab-mounted display screen.

9.2.3 Rail wagon tanks

The design, construction, modification, maintenance, testing and examination of rail wagon tanks is governed by RSSB Requirements for the design, construction, test
9.2.4 Ship and barge tanks

The tanks of ships and barges for the transport of hot bitumens should be specifically designed for the temperatures and characteristics of the products. Further guidance on the design and construction of such tanks is outside the scope of this Code. See also 9.9.

9.2.5 Isotainers and bitutainers

Bitumens and special product formulations (concentrates and modified bitumens) may be transported in isotainers (heated or unheated) or bitutainers (at temperatures less than 100 °C); these are reheated on delivery.

9.2.6 Internal heating tubes

Road tankers and rail wagons for the transport of bitumen may be fitted with steam coils or flame tube heaters.

Where flame tube heaters are fitted, their vertical exhaust risers may be mounted on the outside of the tank or may pass through the tank ullage space. Where an internal exhaust riser is fitted, high surface temperatures in the tank ullage space should be avoided by means of suitable insulation.

Flame heating tubes and exhaust risers should always be maintained in a clean condition as soot and rust can give rise to overheating causing local hot spots. They should be examined frequently for signs of thinning and they should be replaced as necessary.

Figure 9.1 - Generic hazard warning panel and secondary hazard warning diamond for bitumen road tankers and rail wagons

Notes:
1  The code, figures and symbol in the boxes and the dimensions of the panel and secondary hazard warning diamond, are as specified by CDGUTPER. The Code 2W and the symbol in the diamond panel indicate that the load carried is a hot liquid, with the number 3257 being allocated in the UK for bitumen.
2  Whilst most bitumens fall under the UK identification number 3257, those having a flash point below 55 °C (i.e. cutback bitumens) are covered by the identification number 3256 and the hazard warning symbol is that appropriate to flammable liquids.
3  There is no equivalent to 3257 in ADR, and the number shown in countries using this system is 3256, with the appropriate hazard warning number 30, and the ADR diamond hazard warning sign.
### Transport Emergency Card (Road)

**Substance Identification No 3257**

**Emergency Action Code 2 W**

| Cargo | BITUMEN (HOT)  
Hot black liquid with perceptible odour.  
Does not mix with water. |
| Nature of Hazard | High temperatures of product will cause severe burns if in contact with the skin.  
Any introduction of water, because of the high product temperature, can cause the tank to boil over and the hot liquid to be expelled violently.  
All grades will ignite at high temperatures. |
| Protective Devices | Heat resistant gloves with close fitting cuffs (e.g. gauntlet type).  
Full head and face protection with neck-flap fitting over the collar.  
Approved eye protection.  
Heat-resistant heavy duty boots.  
Protective clothing with close-fitting cuffs and leg ends. |
| Emergency Action | NOTIFY EMERGENCY SERVICES IMMEDIATELY |

**Road Accident or Spillage**

- Stop vehicle engine.  
- Shut off leaks if this can be done without risk.  
- Keep public away from possible danger area.  
- No naked lights. No smoking.  
- Contain leaking liquid with sand or earth.  
- Prevent liquid entering drains, basements, etc.  
- If substance has entered a water course or drain or has contaminated soil or vegetation, inform the environment agency by telephoning 0800 807 060.  
- If exposed to fire keep vehicle tank cool using a fine water spray (fog).  
- Extinguish fire by dry chemical, foam or fine water spray (fog).  
- Do not use water jet.  
- If the substance has splashed into eyes, cool immediately with cold running water for at least 5 minutes.  
- Skin burns should immediately be plunged under cold running water and held there for at least 10 minutes or until thoroughly cold.  
- No attempt should be made to remove cold bitumen which has adhered to the skin.  
- Send casualty to hospital.  

**Fire**

**First Aid**

- If the substance has splashed into eyes, cool immediately with cold running water for at least 5 minutes.  
- Skin burns should immediately be plunged under cold running water and held there for at least 10 minutes or until thoroughly cold.  
- No attempt should be made to remove cold bitumen which has adhered to the skin.  
- Send casualty to hospital.  

Additional information will be provided by the supplier or their agent. Telephone.............

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**Figure 9.2 - Generic TREM card for bitumen**

Notes:

1. This TREM card should meet the requirements for emergency guidance to be kept available in a road tanker cab and by the driver of a rail train as required by CDGUTPER and RSSB Requirements for the design, construction, test and use of the tanks of rail tank wagons.
9.2.7 Gauges and fittings

Pressure gauges, pressure relief valves and thermowells for thermometers should be fitted to road tanker and rail wagon tanks. They should be designed and located for protection against impact. They should be cleaned regularly.

Service thermometers should be checked against a master thermometer regularly (e.g. annually) as part of a quality management system to help ensure accurate and precise temperature display and thus safe transfer, handling, pumping etc. The master thermometer should be proved at regular intervals to ensure that it is traceable to national standards.

A safe means of access for opening hatches on the top of road tankers and rail wagon tanks should be provided (see 9.8.1).

Road tanker or rail wagon tanks are usually provided with a single bottom outlet having two valves in series to reduce the risk of spillage in the event of valve failure. The inner valve should be designed so that when the tank is in use the valve remains at a temperature sufficient to prevent plugging.

If, due to leakage of the inner valve, a plug of solid bitumen forms between the two valves, discharge pipework should be properly connected before any attempt is made to clear the plug by opening the two valves simultaneously. See 9.11.

Vents should be sited well away from heater exhaust outlets.

Relief valves should be shielded against fouling by bitumen splashes inside the tank.

9.3 ROAD TANKER AND RAIL WAGON GANTRIES

Bitumen and cutback bitumen road tanker and rail wagon tanks are normally loaded through top connections. It is therefore necessary to provide safe means of access to the tank top for loading operations (see 9.8.1).

Gantries should also be provided wherever samples are to be taken from the tops of tanks. See section 11.3.

9.3.1 Layout of road tanker gantries

Traffic lane and gantry layouts in road loading areas should be designed to accommodate, without congestion, the longest road tankers, rigid or otherwise, likely to be used. They should be laid out for one-way vehicle flow and should avoid, where practicable, the crossing of vehicle streams.

Slip roads should be provided to allow road tankers to leave the installation in case of emergency without passing through the gantries. Auxiliary facilities such as washing bays, administrative stops and fuelling stands should not obstruct normal traffic flow.

9.3.2 Construction

Gantries should be constructed in steel and/or concrete. Any cladding sheets used should be of a material that does not support combustion.

The gantry and its equipment should be protected against impact damage from vehicles by the use of bollards, high road curbs or other effective means.

Platforms and stairs should be provided with nonslip surfaces. Open grid platforms and stair treads should be avoided where there is equipment or access for personnel beneath, unless suitable means are provided for protection against bitumen releases.

9.3.3 Control of road tanker and rail wagon movement

Special care is necessary to avoid any accidental movement of a road tanker or rail wagon while any loading or discharge operation is in progress or any person working at high level on the tank top. Written procedures, warning signals and physical stops should be employed as control measures appropriate to each situation.

9.3.4 Access and escape

For personnel access, gantry platforms should allow a free passage at least 0.75 m wide over the entire length. Equipment on the platforms should be positioned to minimise hindrance to operatives and should not expose them to the risks of impact and burns.

Gantries should have safe means of escape at both ends. Caged ladders should not be used for this purpose.

Working platforms, stairways and ramps should be fitted with guardrails, normally at 1 m above platform level, along all open sides.

A hinged and balanced access ramp should be provided at each loading position to enable personnel to walk easily and safely between the gantry and the road tanker or rail wagon top. The ramp should be easily adjustable to cater for vehicles of different heights. Any stair treads fitted should be of the self-levelling non-slip type. Suspended handrails should be provided opposite the ramp at each loading position to provide protection for personnel standing temporarily on road tanker or rail wagon tank walkways.
9.3.5 Control stations

The design of the loading system should be such that loading can be controlled from the gantry without the operative having to stand on top of the road tanker or rail wagon. See 9.8.4. Each gantry should have emergency valves that can be operated both locally and remotely from a safe location to stop quickly all product flow to the gantry. The emergency stop arrangement should be such that no unexpected product flow can occur on reset. For further guidance, see IP Code of practice for drivers’ emergency actions on road loading racks.

9.3.6 Product segregation and identification

Gantries should preferably be dedicated to bitumen and similar products. Combination with Class 1 petroleum product loading should not be allowed.

On gantries that dispense more than one grade or product, each loading system should be clearly marked to indicate the product it serves. See IP Code of practice for a product identification system for petroleum products. See section 8.4.1.

Positive separation should be provided between the piping of paving and similar grades and the piping for cutback bitumens.

9.3.7 Ventilation

If gantry roofs or other weather protection enclosures are used these should be adequately ventilated to avoid excessive concentrations of fumes or hydrogen sulphide during loading.

9.3.8 Lighting and other electrical equipment

Gantries should be provided with sufficient artificial illumination for night-time operation. This should normally give a minimum of 50 lux illumination at the road tanker or rail wagon tank top.

The electrical equipment within the gantry structure should be to a standard suitable for areas classified as Zone 2 for bitumen other than cutback grades: typically, this should be apparatus sub-group IIA and temperature class T2. For cutback grades electrical equipment should be suitable for Class I/ Class II(2)/ Class III(2) products, depending on the flash point of the product: typically, this should be apparatus sub-group II-A and temperature class T3 (see annex C.4).

9.4 PNEUMATIC DISCHARGE SYSTEMS

Any air or inert gas supply system for the discharge of a road tanker or rail wagon tank should incorporate relief valves as necessary to avoid overload by the air or gas supply facilities. It should also incorporate effective knock-out facilities sufficient to ensure that any water that might collect in the gas or air supply system and its piping is removed before the air enters a road tanker or rail wagon tank. Excessive air or inert gas should not be applied and a restriction orifice may be desirable to limit flow. See also 9.8.7.

9.5 PIPEWORK SYSTEMS

Pipework systems should be designed and laid out with care in accordance with section 8.3.13 and kept clear of blockages when not in use as appropriate by:

— continuous hot bitumen circulation;
— trace heating;
— draining empty;
— filling with a less viscous product.

Where blockage nevertheless has occurred, see 9.11. Hot pipework should be insulated or guarded as necessary to protect personnel from contact burns, and where steam tracing is used (see section 8.3.9). Electrical heating elements for pipework should incorporate automatic temperature limitation controls.

9.6 HOSES

9.6.1 Types and specification

Hoses for bitumen and cutback bitumen duties are usually either:

— reinforced rubber construction; or,
— flexible metallic construction.

Hoses and hose assemblies should conform to BS 6130-1 or equivalent national standards.

9.6.2 Couplings

Hoses should be connected by flanged couplings at both ends. In the case of uplifting bitumen, a potting hose can be used: the unflanged end of the hose should be properly secured to the inspection chamber by means of a chain or hose clamp so that it cannot pull out of the vessel due to a surge of product; failure to secure it can give rise to serious worker injuries.
Where hose flanges are designed to take particular bolt or washer fittings, only the correctly matching fittings should be used. Where it is necessary to use gaskets, these should be of the correct material and in good condition. Where flanges are bolted, all the bolt holes should be used. The use of flange clamps should not be permitted unless the flanges are specifically designed to accept the clamps.

9.6.3 Thermal insulation

Metallic hoses may be thermally insulated for worker protection. However, it should be noted that insulation restricts the flexibility of the hose and makes handling more difficult. It also substantially hinders inspection and may conceal corrosion.

9.6.4 Handling and support in use

Hoses and hose assemblies should always be handled with care. They should not be dragged or rolled in a manner that abrades or twists the body of the hose.

A hose, when in use, should be adequately supported along its full length, either by resting on the ground or by suspension using slings with saddles, to spread the load and prevent bending to radii less than the manufacturer's recommendation.

9.6.5 Marking and inspection

Hoses and hose assemblies should be permanently and legibly marked in accordance with BS 6130-1 or equivalent national standards.

On each occasion before use, hose assemblies should be checked by the user for signs of abrasion, splitting, kinking, swelling or flattening of the hose and for any damage to the couplings and their attachments.

They should be visually inspected at least every three months by a competent person, other than the normal user.

They should be removed from service at least annually for examination and testing by a competent inspector in accordance with the manufacturer's recommendations. This will normally entail removal of insulation to facilitate the examination.

Records of inspections, examinations and tests should be kept in a register.

There should be a procedure for deciding when a hose assembly is no longer fit for service. Hoses and assemblies discarded as worn or defective should be destroyed or plainly marked to avoid re-use.

9.6.6 Pressure testing

Hoses of reinforced rubber construction will, in addition to the regular visual inspection, normally require pressure testing to the specific recommendations of the manufacturer or to BS 1435 and BS EN 1765.

Hoses of flexible metallic construction may require pressure testing but only within the specific guidelines recommended by the manufacturer. Pressure testing of flexible metallic hose, not carried out within the manufacturer's recommendations, can seriously weaken the hose and might render it unsuitable for further service.

9.7 DRAINING OF LOADING ARMS, CHUTES AND HOSES

Buckets or other similar containers, of adequate capacity and with means for the disposal of their contents safely, should be provided for the draining of loading arms and chutes and for disconnected hoses after road tanker or rail wagon loading and closure of the filling valves. At delivery locations, these should be provided by the customer.

9.8 ROAD TANKER AND RAIL WAGON OPERATIONS

9.8.1 Safe work at height

To prevent falls, the need for routine access to road tankers or rail wagon tank tops should be minimised, where possible. Where access is required, then both a safe means of access and a safe place of work should be provided. To meet the requirements of The Work at Height Regulations, high-level access should be subject to a risk assessment that considers the tasks to be performed, their frequency, equipment and PPE needed, possible exposure to adverse weather, and the competence, fitness, and supervision of the operatives who will carry out the tasks.

The minimum engineering provision for opening hatches (see 9.2.6) on the top of road tankers and rail wagon tanks should be a fixed ladder and a non-slip walkway of adequate width to the barrel, in conjunction with personnel restraint systems.

At gantries (see 9.3), additional engineering measures should be provided by way of a gantry with a working platform along or across the road tanker or rail wagon, just above tank top level.
A safe means of access is also required for product sampling (see section 11.3).

9.8.2 Preparation for loading

It should be checked that the discharge and drain valves on the road tanker or rail wagon tank are closed before loading is commenced. Care should be taken to ensure that these valves are not open or plugged with solidified bitumen, thereby giving the impression of being closed. Where blockage has occurred, see 9.11.

Hose coupling and handling should be carried out in accordance with 9.6.2 and 9.6.4; where a potting hose is used, care should be taken that the unflanged end cannot pull out of the vessel. Alternatively, loading arms or chutes may be used.

The presence of water or any other material capable of being vapourised in contact with hot bitumen should be meticulously avoided in any part of the loading system, or in the road or rail wagon that is to be loaded, so that hazardous froth-over will not occur.

Continuously heated pipelines will normally be free of moisture, and there should be no interconnections whereby water could be introduced into the loading system.

Where the presence of water in a pipeline is suspected for any reason it should be eliminated before loading or unloading operations are commenced, by cautious blowing with dry air or inert gas. This operation should only be carried out under strict supervision, and at a temperature that does not exceed the pertinent maximum for the grade (see annex B.4).

When a road tanker or rail wagon tank has been used for bitumen emulsion or if, even after draining, the presence of water is suspected, the tank should initially be slowly and only partially filled. Up to one hour should then be allowed to elapse for any water to dissipate and for frothing to subside, before continuing with loading. Anti-foam agents are beneficial in controlling frothing. They are more effective when added before loading commences than when added during the operation. In any case, their use should be cleared with the customer.

9.8.3 Loading temperatures

The temperatures chosen for despatch of bitumens or cutback bitumens in bulk road tanker or rail wagons should be as low as practicable, consistent with efficient onward handling. The loading temperature should not exceed the maximum for the grade given in annex B.4.

9.8.4 Conditions during loading

No source of ignition should be permitted within 3 m of the road tanker or rail wagon while loading.

No person should be on top of or on the ground near the road tanker or rail wagon receiving hot bitumen, in case of a spill or froth-over. See 9.3.5.

As noted in section 3.4.6, there are no specific flow rate restrictions when loading a bitumen road tanker or rail wagon, although it is good practice to avoid splash filling.

The person responsible for loading should constantly observe the operation from the loading control station (see 9.3.5). If they leave the platform, filling should cease and all valves should be closed. An emergency stop in the form of a dead man’s handle may be provided on the loading valve to ensure this. Generic emergency procedures during loading of products are given in IP Code of practice for drivers’ emergency actions on road loading racks.

Should a spillage occur, loading should be suspended. For guidance on planning for spillages, see section 5.4.

In order to minimise exposure of the loader to fumes, especially hydrogen sulphide, loading should not take place in a confined space. Personnel should position themselves upwind of vents and other openings to minimise their exposure. Where ventilation around the loading point is unavoidably restricted, consideration should be given to the provision of LEV to extract fumes.

Sufficient ullage should be left in the road tanker or rail wagon tank after loading to allow for the expansion that will result from any subsequent reheating.

9.8.5 Conditions during transit

All tank top apertures, other than relief valve discharge ports, should be securely closed and fastened before road tanker or rail wagons are moved.

Tanks should not be heated whilst being moved.

9.8.6 Preparation for discharge from road tanker or rail wagon tanks

Reheating of a road tanker or rail wagon tank may be required before the product can be discharged efficiently.

No attempt should be made to reheat bitumen in a transport tank by the use of a steam or flame tube heater when the bitumen level is less than 150 mm above the
heating tubes. When reheating is required in such cases, the level of the contents should first be checked and sufficient hot bitumen of the same grade should be added to bring it at least to this level above the tubes before applying heat.

Before heating, the road tanker or rail wagon should be located in a level position with the brake full on. Fire extinguishers should be readily accessible (see section 4.4.1).

During heating, the tank should be vented to atmosphere and no source of ignition should be permitted near the vent. An operative should continuously attend this process, but access to the top of the road tanker or rail wagon tank should be prohibited while heating is in progress.

Where flame tube heaters have been used, a minimum of 15 minutes should be allowed after switching off, before attempting to discharge the road tanker or rail wagon tank. The bulk temperature of the bitumen during reheating should be kept as low as possible consistent with efficient discharge and should not exceed the temperature limits set out in annex B.8.

Discharge needs to account for the interface with the facility receiving bulk product supplies (see section 10.2). Before commencing, it should always be checked that there is sufficient ullage space (typically +10% of tank capacity) in the reception tank or vessel to contain the load. For further guidance on the receipt of bulk supplies, see section 10.2.1.

9.8.7 Conditions during discharge

Requirements for the presence of an additional responsible person during customer attended deliveries are set out in section 10.2.1.5.

Tanks should not be heated during discharge.

When a road tanker or rail wagon tank is discharging by the use of air or inert gas pressure, the tank valves should be closed as soon as the tank, hose and discharge pipe are empty, in order to minimise the quantity of air or gas blown into the discharge system and the receiving tank. Vent capacity on the receiving tank should be adequate to handle the expected flow into the tank; otherwise, roof failure might occur.

When discharging a tank by means of a pump, it should be adequately vented to avoid creating a vacuum within the tank.

For draining of hoses etc. after discharge is completed, see 9.7.

9.8.8 Preparation for return of empty road tanker or rail wagons

If air or inert gas pressure has been used to facilitate discharge, the road tanker or rail wagon tank should be vented safely down to atmospheric pressure, using the tank vent, before the road tanker or rail wagon is despatched.

A check should be made before departure that all hatches, covers and valves on the vehicle tank are closed and secured in that position.

9.9 SHIP AND BARGE CARGO OPERATIONS

9.9.1 Wharves and jetties

The principal concerns for loading and unloading of bulk bitumen cargoes are that there should be:
— adequate means of access and escape in the event of fire at the loading or unloading manifold;
— adequate ship-shore communication;
— written emergency procedures;
— adequate arrangements for fire-fighting, including provision of first attack equipment (see section 4.4.1) and access for fire-fighting appliances (see section 4.2.1).

For detailed guidance, see ICS/OCIMF/IAPH International Safety Guide for Oil Tankers and Terminals (ISGOTT) and HSE The bulk transfer of dangerous liquids and gases between ship and shore.

9.9.2 Ship tanks

As for any other petroleum cargo, the general procedures described in ICS/OCIMF/IAPH ISGOTT should be followed.

Additional precautions are necessary when handling bitumen in ship tanks. As for shore tanks these include:
— care to avoid overheating of the bitumen product, and/or carbonaceous deposits at the surfaces of tank heating coils, and the uncovering of heating coils;
— regulation of personnel access to tank tops during bitumen heating operations or product movements into or out of tanks;
— precautions to check and protect against the presence of hydrogen sulphide in tank ullage spaces and from vents and other tank openings;
9.10 PACKAGING

9.10.1 Containers

Packages should be checked before filling to ensure that they are mechanically sound. Their interiors should be dry. All packages (e.g. cardboard kegs) should be of types known to be suitable for filling with hot liquid bitumen.

Containers should be marked for identification with the product grade in accordance with the IP Code of practice for a product identification system for petroleum products. This will help to alert personnel and others to the possible presence of a dangerous substance and help avoid inadvertent mixing of contents. Other than cutback bitumens being labelled as flammable liquids, hard, oxidised, paving grade and polymer-modified bitumens are not classified as hazardous for supply under CHIP (see section 2.2.1).

Note that when carried by road or rail as a hot liquid, bitumens are classified as dangerous goods and are therefore listed in HSE Approved carriage list (see 9.2.1).

9.10.2 Conditions during and after packaging

No source of ignition should be permitted near packaging operations.

Manual handling of hot packages should be subject to a risk assessment. Control measures include keeping manual handling to a minimum. No attempt should be made to move packages until their contents have cooled.

Filling temperatures should be below the upper limit permissible for the type of package and as low as practicable consistent with an adequate filling rate for the bitumen product grade (see annex B.2).

9.11 CLEARANCE OF PIPEWORK BLOCKAGES

Notwithstanding arrangements and procedures designed either to keep bitumen pipework hot or to drain it when not in use (see 9.5), pipework blockages occur occasionally due to cooling and solidification of the product. The methods used to clear such blockages will depend upon the circumstances.

Burning oil-soaked rags must not be used for this purpose.

Controlled flame heating, using an LPG torch or equivalent on the outside of a pipe or valve to clear a blockage within, should be allowed only where there is no reasonably practicable alternative. Where flame heating is permitted locally, a specific procedure should be established for each particular set of circumstances and should be carried out under a PTW by a competent person experienced in the application of flame heating. As an additional control measure, a fire extinguisher should be at hand when flame heating is applied (see section 4.4.1).

Flame heating should never be applied:
— in a location classified as hazardous (see sections 3.4, 8.2.1.3, 8.2.2.3 and Annex C);
— when the pipework system is under pressure, or contains cutback bitumen;
— in conjunction with blowing by air or inert gas;
— where the pipework system is blocked in by valves or might be blocked in by solid plugs of bitumen.

The use of air pressure to clear bitumen pipework blockages should be avoided because its discharge is difficult to control, and a breakaway can be hazardous. Where they are available, steam lances can be tried, but steam should not be used internally for attempted displacement purposes.

The use of oil under hydraulic pressure may be considered where it is suspected that only a very limited blockage is present in some poorly heated part of a long line. When this is applied, it is important that the oil chosen should have a flash point in excess of the stock temperature so as not to create a flammable atmosphere in any tank to which the oil might eventually be discharged. The procedure should be carried out under
the control of a competent engineer to ensure that the system is not over-pressured.

Where pipework blockages persist, the only recourse might be to dismantle the system for piecemeal clearance by burning out in an area designated for that purpose.

9.12 OPERATIVE PROTECTION

Loading, discharge and packaging stations should be arranged to protect the operative from splashing, frothing, fumes and spillage, and burns from hot uninsulated surfaces. In addition, procedures should be written to prevent or minimise exposure.

Requirements for health protection set out in Section 2 should be followed, including provision of locally accessible emergency water showers (see section 2.6.1), eye bath facilities, and first aid posters, (see Figure 2.1), following personal hygiene precautions (see section 2.4.3) and using PPE (see section 2.4.4).
10

PRODUCT HANDLING AND USE

10.1 INTRODUCTION

This section gives health, safety and environmental guidance for common bulk and packaged bitumen handling activities, including the receipt of products, and bitumen use applications including:
— roofing and flooring operations;
— asphalt manufacturing plants;
— road and airfield construction and maintenance operations.

Those handling and using bitumen should refer to and apply the generic health, safety and environmental guidance set out in Sections 2, 3, 4 and 5. In particular, Section 2 for guidance on health management including measures to minimise exposure such as engineering controls, procedural controls, personal hygiene precautions, PPE, and first aid/medical treatment for burns and other exposures; Section 3 for guidance on fire risks and their control; Section 4 for guidance on fighting fires involving bitumen, including the type and minimum provision of portable fire extinguishers; and Section 5 for guidance on protecting the environment. In addition, users of bitumen should refer to Section 8 for design, construction, operation, inspection and maintenance of bulk storage installations; Section 9 for guidance on the interface during bitumen unloading operations, and Section 11 for guidance on sampling.

Whilst this Code focuses on bitumen-specific health, safety and environmental issues, those handling and using bitumen should also assess risks arising from general hazards arising from working with bitumen, such as pressurised discharge of hot bitumen, manual handling of product packages and cumbersome equipment, the close proximity of moving traffic to many work sites, and non-bitumen health and environmental hazards (e.g. hazardous dust arising from aggregate handling).

For worker exposure to bitumen fumes by inhalation, the approach in this revised Code is to present generic exposures in bands for particular processes/activities and occupations/tasks (see section 2.3.2). Whilst general control measures to minimise exposure such as personal hygiene precautions and use of PPE are given in sections 2.4.3 and 2.4.4 respectively, additional control measures necessary to ensure health protection for specific handling and using bitumen activities are described in this section.

10.2 BULK SUPPLIES

Bulk supplies may be delivered by road, rail or ship. Installations receiving bitumen in bulk provide delivery valves, storage tanks and pipework systems as necessary for receiving and transfer of the product to the points of use. Whilst allowing for the difference in size, design and operation, they should follow the guidance given in Section 8.

10.2.1 Safe delivery of bulk bitumen

This section is based on the requirements for deliveries by road tanker set out in RBA Code of practice for the safe delivery of bitumen products; guidance is set out on layout, equipment, operations, PPE, and training requirements. In addition, guidance is provided on generic unloading procedures. Discharge needs to
account for the interface with the facility receiving bulk product supplies (see section 9.8.6).

10.2.1.1 Customer site

The requirements at a customer site are:

— Clearly defined safe routes to and from the delivery point should be provided, including access to and from weighbridges for both road tankers and personnel, including:
  - if drivers are required to weigh in and out, a walkway to enable safe access to and from the road tanker;
  - well-lit approach routes, particularly during hours of darkness.
— A safe and readily accessible delivery point should be provided that accounts for or includes:
  - near-by haul roads and traffic routes;
  - the need for road tanker reversing to be kept to a minimum;
  - a flat even surface for the road tanker, where the driver can discharge the load safely and be protected from other traffic movements;
  - unrestricted movement around the road tanker;
  - no access within 6 metres for pedestrians not involved in delivery operation;
  - adequate lighting in the discharge area;
  - an area which is tidy and clear of obstruction;
  - no surrounding or adjacent operations which could impair a safe delivery;
  - a safe exit route in the event of an emergency.
— An emergency shower should be provided within 20 metres of the discharge point, together with signs indicating its position (see section 2.6.1). Advice on the treatment of bitumen burns should be displayed in the delivery area (see Figure 2.1).
— Instructions for safe operations and emergency actions should be displayed in the delivery area (see section 4.2.2).
— All receipt facilities, including delivery points, tank gauges and vent pipes should be regularly cleaned, checked for serviceability and any defects logged and rectified.
— A method should be provided for the collection and disposal of all hose drainings (see section 9.7).
— A dry chemical fire extinguisher should be provided in close proximity to the delivery flange (see section 4.4.1).
— Customers and suppliers are jointly responsible for ensuring that drivers are aware of all site-specific safety and emergency procedures.

10.2.1.2 Customer storage and associated pipework

Requirements for customer storage and associated pipework are:

— Sufficient tank space should be available to take load +10 % of the tank capacity.
— Each tank and its associated delivery pipe should be independently and uniquely identified with both the tank number and grade (see section 8.4.1) and be visible from the driver’s position at the discharge point.
— Adequate reliable means of gauging the tank contents and ullage should be available. To avoid errors, such gauges should clearly identify which tank they refer to, and be visible from the delivery point. Serviceability of contents gauges should be regularly checked and maintained to the highest standard. Wherever possible a duplicate system should be provided in the plant control centre.
— A high-level alarm system should be fitted. Its activation should be independent of the contents gauging system. To avoid product spillage whilst the delivery hose/line is being cleared, the alarms should be set to trigger at the maximum tank contents less 10 %. Alarms should clearly identify which tank they refer to, when activated. High-level alarms should be regularly tested and maintained to the highest standard.
— Content gauges and high level alarms should be clearly visible and audible to those responsible for the safe receipt of product.
— Overflow and vent pipes should be located where they do not pose a risk to personnel or road tankers and should be kept clear at all times.
— Tank lids should be kept closed at all times and should be fitted with a protective grating to prevent unauthorised or accidental access by personnel. If in the event of a product overflow, there is a danger of bitumen spilling onto the delivery area or any other populated areas, action should be taken to protect people and the environment. For guidance on planning for environmental protection from spillages, see section 5.4.
— Customer delivery pipework should be of adequate design, well-supported and maintained and fitted with a suitable delivery flange, 20 mm thick, located 0,5 m-1,0 m above ground level.
— Access to the customer’s delivery flange should allow for safe and easy connection of the delivery hose.
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— Some customer tanks may be fitted with fill pipes that go to the bottom of the tank, to minimise oxidation. Such fill pipes should be slotted, or fitted with an alternative device, to prevent siphoning.
— Distance between road tanker and the storage tank flanges should not be more than 2.5 metres.
— A flange security system, such as padlocks, should be fitted to maintain control of the delivery point and prevent contamination. Each system should be robust, tank-specific and fit for purpose. A secure key control system should be employed. Tanks should be fitted with correctly designed facilities to enable product to be uplifted from the tank and the tank to be emptied for cleaning and maintenance.
— Where there is a requirement to take tank samples, a purpose-designed valve should be permanently fitted to the tank or corresponding pipework (see section 11.4). Samples should not be taken from the road tanker or delivery hose.
— Access ladders and walkways on tank roofs should be fitted with suitable guards to prevent falls such that they meet the requirements of The Work at Height Regulations.
— Where bitumen emulsion tanks are present, it is imperative that supply and return pipework are segregated from the bitumen pipework system. Fill point connections should be of the screw-on type, to prevent erroneous connection.
— Where a bitumen tank is being returned to service, great care should be taken to ensure that it is free of water. For guidance on management of residual water in storage tanks, see section 8.4.5 or contact the RBA.

10.2.1.3 Driver’s PPE
Road tanker drivers (or similar operatives) delivering bitumen products should be provided, by their employer, with PPE suitable for use in loading and discharging operations where there is a significant risk of splashing. The minimum requirements, which amplify the generic guidance provided in section 2.4.4, are:
— company uniform;
— coveralls/boiler suit;
— safety boots (with coverall/boiler suit worn over top of boots);
— hard hat, full face visor, chin guard, eye protection and neck apron;
— high visibility waistcoat or overcoat; and,
— gauntlets (with boiler suit/coverall over top of gauntlets).

That PPE should meet the following specification:
— body protection:
— company uniform:
  - trousers;
  - shirt; and,
  - jacket.
— coverall/boiler suit:
  - Proban-type treated/flame retardant conforming to BS EN 470-1 and BS EN 531 (type AB1C1);
  - washable; and,
  - high visibility or natural colour.
— protective footwear, in the form of safety boots, such as rigger boots:
  - manufactured to BS EN ISO 20345;
  - 200 Joule toe cap protection;
  - anti-slip and anti-static soles;
  - heat resistant up to 250 °C; and,
  - water, oils, chemical and solvent resistant.
— head protection, incorporating hearing and eye protection:
  - hard hat approved to BS EN 397;
  - full face visor with chin guard approved to BS EN 166;
  - eye protection approved to BS EN 166 (type 1F);
  - neck apron; and,
  - ear defenders approved to BS EN 352-2.
— high visibility:
  - waistcoat: two band and braces approved to BS EN 471 Class 3; or,
  - overcoat: two band and braces approved to BS EN 471 Class 3.
— hand protection by gauntlets/gloves:
  - protection against mechanical and chemical hazard category II;
  - approved to BS EN 420 and BS EN 388; and,
  - forearm protection.

Road tanker drivers (or similar operatives) should be trained in use and maintenance of that PPE.

10.2.1.4 Road tanker first response safety equipment
The road tanker (or other mode of transport) should carry the following first response safety equipment for loading and discharging operations:
— eyewash bottle (see section 2.6.1);
— fire extinguishers (see section 4.4.1);
— first-aid kit (see section 2.6.1);
— wheel chocks;
— traffic cones or warning triangles;
— marking;
— labelling;
— brush;
— shovel;
10.2.1.5 Generic procedures for customer attended deliveries

Generic procedural requirements for safe deliveries in the presence of the customer are:

— The customer should confirm that the product grade and quantity being delivered are correct in relation to transmitted orders.

— The customer’s representative is responsible for:
  - nominating the appropriate storage tank and receiving flange for the delivery;
  - certifying that there is sufficient ullage to receive the full road tanker or rail wagon tank load, plus 10%;
  - signing the driver’s documentation prior to delivery;
  - ensuring lines and valves are routed to correct tanks;
  - verifying that there is no water in the tank;
  - verifying that the temperature of the product is within temperature limits in accordance with pertinent quality management systems.

— The customer’s representative must visually monitor the driver’s safety during the discharge operation by one of the following methods:
  - visual observation, e.g. by line of sight or closed circuit television (CCTV);
  - regular checks;
  - attending the discharge location with the driver whilst wearing appropriate PPE (see 10.2.1.3), provided by their employer.

— Unauthorised personnel should be excluded from the area surrounding the delivery hose. Where a tank is situated inside a building that is poorly ventilated, entry into that building should be restricted to authorised personnel only, and during discharge, local activities inside the building should be kept to a minimum. At no time during the discharge operation should anyone be on top of the storage tank.

— Split loads should be avoided; however, if the load is to be delivered into more than one tank at a site, each tank should be treated as a separate delivery point. If the road tanker needs to be moved, the delivery procedure should be repeated in full. This will require the removal of the delivery hose from both road tanker outlet and customer’s flange.

Delivery documents should be endorsed accordingly, to identify the additional tank(s) and in particular, that ullage and grade checks have been completed prior to delivery.

— On completion of delivery, the driver will clear all discharge pipework and disconnect the tanker hose. Hose drainings should be disposed of in the receptacle provided by the customer for this purpose.

— On completion of delivery, the customer’s representative should complete and sign the delivery documents to acknowledge receipt of load. The customer’s representative should also confirm that the flange security system is reinstated.

— The driver is solely responsible for the operation of the road tanker and equipment throughout the discharge procedure and should remain by the vehicle shut-off valve whilst discharge is taking place. The driver should wear PPE at all times during the discharge process (see 10.2.1.3).

— Any deficiency in the tanker driver’s delivery procedures should be promptly reported to the site management and bitumen supplier so that corrective action can be taken.

— Drivers are encouraged to report any defects that they identify at customer sites, so that corrective action can be taken.

10.2.1.6 Bitumen-specific training

Drivers transporting and delivering bitumen products must receive regular training in order to maintain their competence in:

— CDGUTPER/ADR;
— RBA hazard awareness/passport;
— Employer-specific driver training programmes.

Customer representatives should receive training on the safe receipt, storage and handling of bitumen products. Most bitumen suppliers can offer assistance in training. Training requirements should be reviewed regularly and training records should be kept on file.

10.2.2 Storage tanks

Whilst allowing for the difference in size, design and operation, the guidance given in Section 8 is applicable to bulk receipt storage tanks at customer premises. Particular attention should be given, both through design and operation, to maintain product temperatures below the maxima set out in annex B.2; to avoid local overheating (see section 8.3.2); and to uncover heating elements (see section 8.3.2.3).

If these conditions are correctly observed during the storage of paving, hard and oxidised grade bitumens, it
is unlikely that vapour evolved into the confined ullage space will reach the flammable range. Nevertheless accurate temperature control to minimise the possibility of carbonaceous deposits becoming self-heating, should be carried out as good practice in avoiding fire and explosion (see sections 8.4.3 and 8.4.7).

Since the vapour produced during the storage and delivery of cutback bitumen grades is likely to be in the flammable range, a similar control regime is necessary in order to minimise expulsion of flammable vapour from the vent and other tank openings.

Unlike bitumen storage tanks for onward distribution, product user storage is subject to the requirements of regulations on oil storage, although there are some exemptions (see section 5.3).

**10.2.3 Pipework systems**

Pipework systems for occasional use should, as noted in section 8.3.13, be designed for ease of draining to low points from which the product can conveniently be removed between operations. For any bitumen pipeline to be self-draining, it should be inclined at not less than 8%.

Pipework systems that might be left full of product between operations should have adequate thermal insulation and trace heating facilities to prevent blockage due to product solidification. Where trace heating is provided, particular care is necessary to avoid heating liquid-full sections trapped between closed block valves or plugs of solid product. Pressure relief valves cannot normally be relied upon to protect sections of heated liquid-full bitumen pipework against the hydraulic pressures that can be produced by thermal expansion. Where electrical trace heating is used, it should be fitted with automatic temperature limit controls.

Pipework systems, whether for occasional or continuous use, should be thermally insulated as necessary to protect personnel from contact burns.

Flanged pipe connections are preferred to screwed connections in bitumen service, to facilitate dismantling when necessary for the clearance of blockages.

**10.2.4 Safe clearance of pipeline blockage**

Unsafe methods of attempting to clear pipeline blockages can give rise to serious accidents due to the heated nature of the product; therefore, they should not be permitted.

The precautions listed in section 9.11 should be followed.

**10.3 PACKAGED SUPPLIES**

Bitumens that are solid at ambient temperature can be supplied in lightweight steel drums, cardboard kegs, plastic tubs, paper sacks or plastic wrappings.

Cutback bitumens and bitumen emulsions can be supplied in heavy gauge steel drums. They should be stored on drip trays (see section 5.3).

**10.3.1 Removal of solid bitumen from drums**

Solid bitumen can be removed from a lightweight steel drum either by melting from the drum or by cutting away the drum using a cold chisel; appropriate PPE should be worn during such operations (see section 2.4.4).

Care is necessary when melting from the drum to avoid localised over-heating. Normally both ends of the drum should be removed before any heat is applied. Heating should then be applied generally to the full length of the drum. This can best be done by placing the drum on a specially designed grid over the mouth of the bitumen heating unit or kettle into which the product is to drain.

When using a cold chisel, care is necessary to protect all those in the vicinity from impact with dislodged flakes of bitumen and metal.

**10.3.2 Melting solid blocks of bitumen**

Bitumen blocks, after removal as necessary of the cardboard or plastic coverings, should, where practicable, be reduced in size using hammers or chisels before being added to a kettle.

When charging lumps of bitumen into a kettle, special care is necessary to protect personnel from splashes of the molten product. This entails both well-designed feeding arrangements and suitable PPE (see section 2.4.4).

**10.3.3 Removal of cutback bitumen from drums**

Drums containing cutback bitumen are normally provided with two 50 mm diameter bung holes in one end to enable the product to be dispensed. Cutback bitumens packaged in this way normally flow sufficiently well for them to be poured from the drum at ambient temperature.

If heating is required, special care is necessary because the products contain volatile flammable diluents. The drums should not be heated above 30 °C without removing one of the bungs. Once a bung has been removed, the drum should be kept well away from sources of ignition.
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Personnel should wear PPE suitable for significant risk of splashing during such operations (see section 2.4.4).

Empty drums containing remnants of cutback bitumens are particularly at risk of explosion, if subjected to flame heating. They should be stored with both bung holes open, in a place free from sources of ignition, pending disposal.

10.3.4 Removal of bitumen emulsions from drums

Drums containing bitumen emulsions are normally provided with 50 mm diameter bung holes at one end and halfway down the drum to enable the product to be dispensed with the drum in a vertical or horizontal position. Emulsion products packaged in this way flow well at ambient temperature and the risks associated with handling at elevated temperatures are therefore avoided.

Although handling is carried out at ambient temperature, personnel should wear PPE and avoid skin and eye contact as with other bitumen products.

Part-empty or emptied drums should be stored with bungs firmly in place, to avoid contamination or spillage of the contents. Waste drum contents should be disposed of in accordance with local and national regulations, and the contaminated empty drums should be disposed of through an authorised contractor or collector. Disposal information should be included in the supplier’s MSDS.

10.4 MOBILE HEATING KETTLES FOR BITUMENS AND MASTIC ASPHALTS

Kettles are extensively used during roofing and flooring, construction and maintenance for heating bitumen products. They are usually fitted with a lid sufficient to stop rainwater entering and are heated from beneath by a bottled gas burner. This type of kettle should never be used for heating cutback bitumens.

Drums should not be used for the melting or holding of molten bitumen stocks unless specifically designed for the purpose.

When bottled gas is employed for heating a kettle, those cylinders actually in use should be separated not less than 3 m from the kettle; any cylinders not in use should be located at least 6 m from the kettle. Provision should be made for the kettle to stand in a metal drip tray of sufficient capacity to prevent any bitumen spillage from the kettle reaching the cylinders.

Gas supply lines should be protected against damage. For other precautions in the use of LPG fuel and its equipment, see section 3.5.3.

10.4.1 Transport and siting of kettles

Kettles should not be heated during transit.

Transportable kettles should be set on firm, level foundations before being heated. After use, their contents should be allowed to solidify before they are moved.

10.4.2 Heating of kettles

Temperatures should be kept as low as practicable, consistent with efficient application of the product.

It is accepted that the process requirements involved with kettle use differ from those of bulk bitumen storage and handling, and working temperatures for bitumens tend to be high. This brings increased risk of degradation and ignition (or even auto-ignition) (see section 3.4.3) if the bitumen is kept hot for a long period. Hence, for quality and safety, health and environmental protection reasons, bitumens should not be kept hot for a long time with the kettle lid open.

For most operations, it should not be necessary to exceed the normal temperature limits. For RBM roofing applications, temperature guidance given in pertinent user standards should be consulted, such as those of the Flat Roofing Alliance (FRA), BS 8217, etc. These allow for the expected cooling between kettle and point of use.

The following control measures should be applied to the heating of kettles:

— Responsibility for kettle operations should be assigned to one operative.
— Kettles should not be left unattended while they are being heated.
— Kettles should never be filled above the capacity level specified by the manufacturer.
— Kettles should only be filled as required to give an adequate supply of hot bitumen for the task.
— When heating from cold, heating rates should be kept low until the product is clearly fluid and any water present has been driven off.
— The temperature should be carefully controlled and monitored by taking reliable readings from thermometers that are calibrated frequently (because site conditions may cause damage). This could also be achieved by the use of a thermostatically-controlled kettle (which should be calibrated regularly).
— The heated bitumen should be used as soon as possible after attaining the requisite temperature.
— The kettle lid should only be opened when necessary.
—— Sources of ignition should be kept away from the proximity of the lidded area, especially when removing bitumen from the kettle.

Molten product should be removed from the kettle using either a side branch or a ladle. It should be conveyed to the point of use in suitable containers with external handles (e.g. bucket with a spout or pouring can) by persons wearing PPE (see section 2.4.4).

Workers should minimise inhalation of fumes from hot bitumen kettles; to control exposure, wherever possible kettles should be sited downwind of the work area.

10.5 ROOFING

10.5.1 Oxidised bitumens and RBM roofing

Oxidised grade bitumens are used as 'pouring and mopping' adhesives for fixing of RBMs for roofing. The precautions for using packaged bitumens (see 10.3) and heating in kettles (see 10.4.2) should be followed.

The normal technique for laying RBMs is known as 'pour and roll'. The bitumen is heated in a kettle to the application temperature specified in appropriate user standards referred to in 10.4.2. The bitumen is transported from the kettle to the work area in a bucket or spouted can and poured onto the substrate in front of the roofing membrane. The membrane is unrolled into the bitumen whilst it is still hot and liquid. The poured bitumen spreads to give a continuous adhesive coating for the full width of the roll. For small areas such as detailing, the bitumen is mopped on and the membrane adhered.

The risks of spills and potential for burns should be minimised by selecting a safe, unhindered route from the kettle to the roof area and by operatives wearing appropriate PPE (see section 2.4.4). Typical fume exposures to roofing team personnel are summarised in Table 2.3. Where possible, exposure should be minimised by working as far as reasonably practicable on the upwind side of the work. As an additional control measure, use of RPE should be considered for work in still air conditions.

10.5.2 Mastic asphalt roofing

Mastic asphalt (blends of paving or hard grade bitumens with finely ground mineral fillers) is used for roofing.

The material is applied hot. Small contracts use mobile heating kettles (see 10.4); the precautions for using packaged bitumens (see 10.3) and heating in kettles (see 10.4.2) should be followed. For larger contracts, the material is remelted in mechanical mixers or delivered to site in hot charge mobile machines. The temperature of the material should not exceed 230 °C, as stated in pertinent user standards, which are BS 6925 for manufacture and BS 8218 for application.

The risks of spills and potential for burns should be minimised by selecting a safe, unhindered route from the kettle, mechanical mixer or hot charge mobile machine to the roof area and by operatives wearing appropriate PPE (see section 2.4.4). Molten product should be removed from kettles by a ladle or using the banjo of a mechanical mixer or hot charge mobile machine. It should be conveyed to the point of use in suitable containers with external handles (e.g. bucket with a spout or pouring can), using a bucket trolley where necessary. The material is then trowelled to produce an even surface.

Typical fume exposures to roofing team personnel are summarised in Table 2.3. Where possible, exposure should be minimised by working as far as reasonably practicable on the upwind side of the work. As an additional control measure, use of RPE should be considered for work in still air conditions.

10.6 MASTIC ASPHALT FLOORING

Mastic asphalt is used for flooring.

The material is applied hot having been remelted in mechanical mixers or delivered to site in hot charge mobile machines. The temperature of the material should not exceed 230 °C, as stated in pertinent user standards, which are BS 6925 for manufacture and BS 8204-5 for application.

The risks of spills and potential for burns should be minimised by selecting a safe, unhindered route from the mechanical mixer or hot charge mobile machine to the floor area and by operatives wearing appropriate PPE (see section 2.4.4). Molten product should be removed using the banjo of a mechanical mixer or hot charge mobile machine. It should be conveyed to the point of use in suitable containers with external handles (e.g. bucket with a spout or pouring can) using a bucket trolley, where necessary. The material is then trowelled to produce an even surface.

The health hazards are similar to those of roofing but, because of the indoor conditions, the troweller, and other personnel in the vicinity, can be particularly exposed to fume levels that could exceed the pertinent OELs. Typical fume exposures to flooring team personnel are summarised in Table 2.3. For any indoor operations with hot mastic asphalt, adequate ventilation should be ensured by taking full advantage of all possible natural ventilation. Additional control measures may be identified by the health risk assessment, such as
Asphalts are mixtures of bitumen with mineral aggregates and their use for road and airfield construction and maintenance represents the largest use of bitumen.

10.7 ASPHALT MANUFACTURE AND USE

10.7.1 Hot mixture asphalt

10.7.1.1 Hot mixture asphalt production

Hot mix asphalts are produced either continuously or batch-wise by adding typically 4 to 8 % by mass of paving or hard grade bitumen to hot aggregate, and mixing at a temperature typically in the range 130 to 200 °C (see annex B.5).

Usually, the hot asphalt mixture is discharged directly into waiting trucks for transport to the paving site but, increasingly, some of the production is stored in silos awaiting demand.

Production of hot mix asphalt is subject to LAPPC (see section 5.2), as set out in DEFRA Roadstone coating. Whilst primarily focused on prevention and control of aggregate-related emissions, there are requirements for visual observation of emissions in bitumen deliveries, and application of control measures in handling and storage, such as temperature control.

Typical fume exposure to control cabin and plant operators is summarised in Table 2.3.

10.7.1.2 Hot mixture asphalt paving

Hot mixture asphalts are generally applied using paving machines, the hoppers of which receive the hot mixture directly from delivery trucks. These machines spread and partially compact the applied mixture to a desired thickness and width of pavement, which is then finally compacted by rollers. The laying team comprises the paving machine driver (the paver driver), a raker immediately behind the machine who corrects imperfections in the newly laid asphalt layer, and a screeder at the rear who adjusts the screed to give the desired road profile.

Typical fume exposures to hot mixture asphalt paving team workers are summarised in Table 2.3. Semi-automation and open-air application reduce exposures to a minimum, but the use of excessively high asphalt temperatures under still air conditions will increase unnecessarily the exposure of the paver driver and other operatives to bitumen fumes. Where possible, exposure should be minimised by working as far as reasonably practicable on the upwind side of the work.

Precautions outlined in sections 2.4.3 and 2.4.4 should be taken to prevent skin and eye contact. In addition, for work alongside open highways, operatives should wear high visibility jackets and reflective patches.

10.7.2 Fluxed asphalts

Fluxed asphalts are produced on a smaller scale than hot mixture asphalts, typically by the addition of flux oil to the asphalt mixture during the aggregate coating process, normally batch-wise. Proprietary binders are also available for this purpose. Fluxed asphalts may be produced at temperatures in excess of the flash point of the flux oil or proprietary binder; therefore, appropriate precautions should be taken to eliminate local sources of ignition.

These mixtures may be used to facilitate hand laying for deferred set or depot stock for use in temporary works.

Health and safety precautions associated with the products depend largely on the type and quantity of flux oil employed in their manufacture. This should be determined by referring to the supplier’s MSDS. The potential hazard of prolonged and repeated skin contact becomes greater with further additions of flux oil to the base bitumen; this is particularly the case when flux oils other than kerosine are used.

Personal hygiene precautions should be taken, such as use of barrier creams to assist cleansing (see section 2.4.3). PPE such as impermeable gloves should be worn, together with other protective clothing to prevent skin contamination of other potentially exposed parts of the body (see section 2.4.4). In addition, for work alongside open highways, operatives should wear high visibility jackets and reflective patches.

As the products are generally used in the open air at ambient temperature, exposure to hydrocarbon vapour is minimal, although the health risk assessment (see section 2.3) may require additional control measures (see section 2.4), such as use of RPE (see section 2.4.4.1).

10.7.3 Cold mixture asphalts (emulsion/foamix)

Cold mixture asphalts are produced, on a smaller scale than hot mix asphalts, by mixing at ambient temperatures, special cutback bitumens or fluxed bitumens with dry aggregates, normally batch-wise. These mixes are used for small repair work on paved surfaces, usually with application by manual tools and simple mechanical aids.

Health and safety precautions associated with the products depend largely on the type and quantity of
diluent employed in their manufacture. Its identity should be determined by reference to the supplier’s MSDS. The potential hazard of prolonged and repeated skin contact becomes greater with further additions of diluent to the base bitumen; this is particularly the case when diluents other than kerosine are used.

Personal hygiene precautions should be taken, such as use of barrier creams to assist cleansing (see section 2.4.3). PPE such as impermeable gloves should be worn, together with other protective clothing to prevent skin contamination of other potentially exposed parts of the body (see section 2.4.4). In addition, for work alongside open highways, operatives should wear high visibility jackets and reflective patches.

As the products are generally used in the open air at ambient temperature, exposure to hydrocarbon vapour is minimal, although the health risk assessment (see section 2.3) may require additional control measures such as use of RPE (see section 2.4.4.1).

10.7.4 Mastic asphalt paving

Mastic asphalt can be used for paving where waterproofing is also required. It is used in conjunction with mastic asphalt roofing (see 10.5.2).

The material is applied hot. Small contracts use mobile heating kettles (see 10.4); the precautions for using packaged bitumens (see 10.3) and heating in kettles (see 10.4.2) should be followed. For larger contracts, the material is remelted in mechanical mixers or delivered to site in hot charge mobile machines. The temperature of the material should not exceed 230 °C, as stated in the pertinent user standard, which is BS 1447 for manufacture and application.

The risks of spills and potential for burns should be minimised by selecting a safe, unhindered route from the kettle, mechanical mixer or hot charge mobile machine to the application area and by operatives wearing appropriate PPE (see section 2.4.4). Molten product should be removed from kettles by a ladle or using the banjo of a mechanical mixer or hot charge mobile machine. It should be conveyed to the point of use in suitable containers with external handles (e.g. bucket with a spout or pouring can) using a bucket trolley, where necessary. The material is usually trowelled to produce an even surface; however, for larger contracts, mechanical assistance may be used.

Typical fume exposures to paving team personnel are summarised in Table 2.3; for outdoor operations, refer to data for roofing, whereas for indoor operations (e.g. paving in car parks), refer to data for flooring. Where possible, exposure for outdoor operations should be minimised by working as far as reasonably practicable on the upwind side of the work. As an additional control measure, use of RPE should be considered for external work in still air conditions. For indoor operations, the troweller, and other personnel in the vicinity, can be particularly exposed to fume levels that could exceed the pertinent OELs. For any indoor operations with hot mastic asphalt, adequate ventilation should be ensured by taking full advantage of all possible natural ventilation. Additional control measures may be identified by the health risk assessment, such as provision of effective LEV near the work area, or if not, by using RPE (see section 2.4.4.1).

10.8 SURFACE DRESSING OF ROADS

The road maintenance technique of surface dressing entails spraying the road with a thin film of binder, which may be cutback bitumen, paving grade bitumen or bitumen emulsion binders. This is followed by the application of a layer of stone chippings (crushed aggregate, slag or gravel). The road is then rolled to embed the chippings into the surface.

The binders are typically stored hot in fixed or mobile storage tanks from which they are pumped, or gravity fed, into mobile spray vehicle tanks as required. These are then driven to the application site.

Spray vehicle tanks are fitted with flame tube heaters in order to be able to heat or maintain the temperature of the binder to that required for spray application. This is necessary for example, when periods of inclement weather have delayed the start of a surface dressing operation. Storage tanks may also be fitted with flame tube heaters.

For general precautions in the safe use of LPG fuel and equipment, see section 3.5.3.

For general precautions for protecting the environment, see section 5.4, whereas see 10.2.1.4 for environmental protection guidance with regard to carriage of bitumen.

10.8.1 Operations using cutback bitumens as binders

For cutback bitumen spray operations, personal hygiene precautions should be taken, such as use of barrier creams to assist cleansing (see section 2.4.3). PPE such as impermeable gloves should be worn, together with other protective clothing to prevent both low and high temperature skin and eye contact (see section 2.4.4). In addition, for work alongside open highways, operatives should wear high visibility jackets and reflective patches.
10.8.1.1 Use of flame tube heaters
The temperatures necessary for spray application of cutback bitumens are given in annex B.6.

No flame tube heater should be operated whilst product transfer operations or spraying are taking place in the vicinity. Where external flue heaters are not fitted, the heater should have been extinguished and left to cool for at least 15 minutes before the start of any such operation, due to the possibility of ignition by hot surfaces.

The spray vehicle should be located on level or near-level ground with the hand brake fully applied before commencing heating. The flame tube heater should not be used unless there is everywhere within the tank a covering of at least 150 mm of cutback bitumen over the heating tubes.

The tank should be adequately vented, remotely from the driver and the flame tube flue discharge, and its contents circulated throughout the heating process.

Before the heater is ignited, two foam or dry chemical fire extinguishers should be placed in a safe location on opposite sides of the vehicle, but within easy access for the operative at the burner front (see Table 4.2). When igniting the flame tube heater, the operative should not stand directly in line with the flame tube in case there is a flashback.

During heating and for a minimum of 15 minutes thereafter, the operative should continue to attend the heater to ensure that the cutback bitumen is not heated beyond the maximum temperature for the grade in annex B.6, and that there are no operations nearby that might release vapours from the cutback bitumen before the flame tube is cool.

10.8.1.2 Transfer of cutback bitumen to spray vehicle tank
Before transfer of cutback bitumen from the supply tank to the spray vehicle tank, all flame tube heaters should be extinguished and sufficient time given for them to cool down, due to the possibility of ignition by hot surfaces. This should be at least 15 minutes.

The spray vehicle itself should stand on level or near-level ground with the hand brake fully on. At no time during the transfer of cutback bitumen should the vehicle be left unattended.

Before any transfer of cutback bitumen to a spray vehicle takes place, there should be no water or bitumen emulsion in the tank or its fittings. If the presence of water is suspected, action should be taken to dispel it before filling with cutback bitumen. This may be achieved by transferring a small quantity of cutback bitumen at a temperature in excess of 100 °C, sufficient only to enable circulation through the spray bar, and to circulate this until frothing and evolution of steam have subsided.

The hose for transferring the cutback bitumen from the supply tank to the spray vehicle should be of the correct quality (see section 9.6) and in good condition. It should be correctly attached to the vehicle tank-filling flange and not placed loosely through the tank access chamber.

During the transfer of cutback bitumen, there should be no naked lights or other sources of ignition near the tanks.

Overfilling should be avoided and sufficient ullage space should be left to allow for expansion of the contents when further heated.

After filling, but before moving off, all hoses and access chamber covers should be secured and the appropriate hazard warning panels should be clearly displayed as the vehicle is effectively transporting dangerous goods (see section 9.2.1).

10.8.1.3 Spraying cutback bitumens
In order to minimise fire risks and avoid excessive fuming, the temperature of the cutback bitumen in the spray vehicle tank should be kept as near as possible to the optimum for the grade and should never exceed the pertinent maximum set out in annex B.6.

During spraying, clear warning signs against smoking and naked lights should be displayed at appropriate points on site, visible to members of the public where this is appropriate.

Where practicable, coning or other means should be employed to keep possible sources of ignition at least 1 m from the extremities of the spray bar. Coning also gives operatives room to work around moving machinery without fear of stepping into the line of passing traffic. Where this leaves insufficient room for passing traffic, roads should be closed while spraying operations are in progress.

Typical bitumen fume exposures to spraying team operatives are summarised in Table 2.3. Operatives, and particularly spray bar operators, should minimise inhalation of cutback bitumen fumes by, where possible, taking advantage of wind direction. The health risk assessment (see section 2.3) may identify the need for additional control measures; for example, spray bar operators when working in the open near the spray bar may need to use RPE (see section 2.4.4.1).

10.8.1.4 Personal hygiene precautions
For cutback bitumen spray operations, personal hygiene precautions should be taken, such as use of barrier creams to assist cleansing (see section 2.4.3). PPE such as impermeable gloves should be worn, together with...
other protective clothing to prevent both low and high temperature skin and eye contact (see section 2.4.4). In addition, for work alongside open highways, operatives should wear high visibility jackets and reflective patches.

**10.8.2 Operations using paving grade bitumens as binders**

Spraying operations using paving grade bitumens as binders are less common than those using cutback bitumens. Similar precautions are necessary throughout, including protection of skin and eyes from contact with hot material (see 10.8.1).

**10.8.3 Spraying operations using bitumen emulsions as binders**

**10.8.3.1 Use of flame tube heaters**

When using bitumen emulsions as binders, the spray temperature required is normally in the range 60 to 85 °C.

Precautions to be taken in the handling of bitumen emulsions should be the same as for cutback bitumens (see 10.8.1). Additionally overheating of the bitumen emulsions should be avoided. The temperature should not exceed 90 °C because overheating to temperatures approaching 100 °C can produce boil-over due to the water present.

Flammable atmospheres are not generated by bitumen emulsions at normal working temperatures. It is therefore less important than with cutback bitumens to ensure that flame tube heaters are thoroughly cooled before product transfers or spraying operations commence.

**10.8.3.2 Transfer of bitumen emulsions to spray vehicle tanks**

The same precautions to avoid spills are necessary as when using cutback bitumens (see 10.8.1.2).

**10.8.3.3 Spraying bitumen emulsions**

There are no concerns regarding flammable atmospheres near spraying operations. Coning or other means should be employed to give operatives protection from passing traffic (see 10.8.1.3).

**10.8.3.4 Personal hygiene precautions**

For bitumen emulsion spray operations, personal hygiene precautions should be taken, such as use of barrier creams to assist cleansing (see section 2.4.3). PPE such as impermeable gloves should be worn, together with other protective clothing to prevent both low and high temperature skin and eye contact (see section 2.4.4). All operatives, and particularly spray bar operators, should minimise inhalation of bitumen fumes by, where possible, taking advantage of wind direction. In addition, for work alongside open highways, operatives should wear high visibility jackets and reflective patches.

**10.9 MASTIC ASPHALT TANKING**

Mastic asphalt tanking is used for waterproofing of structures below ground.

The material is applied hot. Small contracts use mobile heating kettles (see 10.4); the precautions for using packaged bitumens (see 10.3) and heating in kettles (see 10.4.2) should be followed. For larger contracts, the material is remelted in mechanical mixers or delivered to site in hot charge mobile machines. The temperature of the material should not exceed 230 °C, as stated in pertinent user standards, which are BS 6925 for manufacture and BS 8102 for application.

The risks of spills and potential for burns should be minimised by selecting a safe, unhindered route from the kettle, mechanical mixer or hot charge mobile machine to the application area and by operatives wearing appropriate PPE (see section 2.4.4). Molten product should be removed from kettles by a ladle or using the banjo of a mechanical mixer or hot charge mobile machine. It should be conveyed to the point of use in suitable containers with external handles (e.g. bucket with a spout or pouring can) using a bucket trolley, where necessary. The material is trowelled to produce an even surface.

Typical fume exposure is summarised in Table 2.3; for indoor operations, refer to data for roofing, whereas for outdoor operations in good ventilation, refer to data for flooring. Where possible, exposure for outdoor operations should be minimised by working as far as reasonably practicable on the upwind side of the work. As an additional control measure, use of RPE should be considered for external work in still air conditions. For indoor operations, the troweller, and other personnel in the vicinity, can be particularly exposed to fume levels that could exceed the pertinent OELs. For any indoor operations with hot mastic asphalt, adequate ventilation should be ensured by taking full advantage of all possible natural ventilation. Additional control measures may be identified by the health risk assessment, such as provision of effective LEV near the work area, or if not, by using RPE (see section 2.4.4.1).
11

SAMPLING

11.1 INTRODUCTION

This section describes the hazards of bitumen sampling, and gives guidance on the engineering and procedural measures to ensure a safe system of work. Reference should also be made to IP 474.

Those undertaking bitumen sampling should refer to the generic health, safety and environmental guidance set out in Sections 2, 3, 4 and 5. In addition, they should refer to Sections 8 and 9 for guidance on sampling at bulk storage installations, in distribution and at customer facilities respectively.

11.2 HAZARDS AND CONTROL MEASURES

Sample needs range in size from a few millilitres for laboratory testing to several hundred litres for equipment trials.

Sampling of hot bitumen is particularly hazardous because of the risks of burns from spills and splashes of the material. Whatever the size of the sample or the methods to be used (see 11.3 and 11.4), PPE suitable for a significant risk of splashing should be worn (see section 2.4.4). The area around tank roofs or tank access gantries should be well lit whenever sampling is required during the hours of darkness.

Sampling of bitumens and cutback bitumens through tank ullage spaces can also be hazardous because of exposure of the sampling technician to tank vapours and the risks of ignition when tank atmospheres are in the flammable range. See 11.3.

As described in sections 7.2.1 and 8.4.6, access by personnel to hot bitumen tank roofs should be avoided, wherever practicable, and no personnel should go onto the tank roof during the mixing or circulation of a cutback blending tank.

Similar restrictions should be placed on sampling during filling or discharge of road or rail tank cars, and of ships or barge tanks. In addition, a safe means of high-level access should be provided (see sections 8.3.1, 8.3.4 and 9.8.1).

Hydrogen sulphide may be present when dip sampling a heated bitumen tank, in the ullage space, on tank tops and particularly the region around dip holes and tank vents. See section 8.4.2. Notwithstanding this, when pumping, gauging or sampling tanks, hydrogen sulphide measurements taken 0.3 m or more from hatch openings are typically diluted to below hazardous levels. Sampling technicians should be informed of the potential hazard and systems of work should be instituted that require them to position themselves upwind and with their faces at least 0.7 m away from such sources of exposure during operational activities. They should also be advised to avoid inhaling vapours, particularly when opening dip holes or hatch covers. The guidance in sections 2.4, 8.4.2 and 9.8.4 should be followed. To avoid the possibility of exposure to hydrogen sulphide, use of automatic level indicators should be considered (see section 8.3.4).

11.3 DIP SAMPLING

Dip sampling involves dipping a weighted can or ‘thief’ on the end of a rope or rod into the surface of the liquid in a tank. The method is simple and can produce, with little waste of product, samples that are representative of
the tank contents. It is normally not satisfactory, however, for taking samples larger than one or two litres.

Sample 'thieves' that can be opened by remote control to take samples at levels below the liquid surface are not normally necessary for bitumen sampling.

Dip sampling gives rise to some risk of introducing air and creating a source of ignition at the sample point. It should therefore be avoided in circumstances where the tank ullage space may contain a flammable atmosphere (see section 3.3.2.2). This is possible in the case of rundown tanks that are connected to receive product from manufacturing processes, and in particular in the case of the air-blown oxidised grades (see section 6.4.1.2). It should also be avoided when tanks are being held under an oxygen-depleted atmosphere (see sections 8.3.8 and 8.3.4).

Dip sampling from cutback tanks in particular should be avoided, or carried out with caution because of the risks of the presence of flammable atmospheres in tank ullage spaces (see sections 3.3.1, 11.2 and 7.3.2).

Where the risks of flammable atmospheres in hot bitumen tank ullage spaces are assessed as being negligible, dip sampling might be preferred, for cleanliness and simplicity, to other methods of taking small samples. See however section 8.4.6.

Provisions should be made to protect the area around the sample point to avoid contamination of thermal insulation materials that might lead to auto-ignition. See section 8.3.10.

Safe access to the sample point, protected by handrails, should be provided. See section 8.3.1. Gantry access should be provided where dip samples are required from road tanker or rail wagon tanks. See section 9.3.4.

11.4 SAMPLE VALVES

Sample valves may be provided for sampling from pipelines or from tanks (see section 8.3.11). They should be designed to be kept sufficiently warm by the product in the pipeline or the tank, to avoid blockage when in the closed position.

The valve may be of the screw driven, plunger type with the plunger, when closed, extending into the fresh product. With this type of valve, a representative sample of the fresh product can be obtained without fore-runnings.

If the sample valve is not of the plunger type it should preferably be a ball or plug type valve with its 'closed' position clearly marked on the stem. With these types of valve, provision should be made to dispose safely and cleanly of the fore-runnings, collected before the representative sample is produced.

The valve discharge nozzle should be firmly fitted but readily detachable for cleaning.

The sample collector should be clamped in place below the nozzle while the sample is being taken and the sample valve operator should be protected against accidental splash or spill by appropriate splash deflectors and overspill collectors, and by wearing PPE described in section 2.4.4.

If the sample does not flow immediately when the valve is cracked open, the valve should be fully closed again and a written procedure for clearing the blockage should be initiated.

Depending upon the particular circumstances and subject to appropriate safety precautions, blocked sample valves can sometimes be cleared by external heating using steam or by oil purging from the outlet end using high flash point oil. See section 9.11. Whichever method is used, the sample valve should not be left unattended in the open position in case the blockage suddenly clears.

Designs for bitumen sampling valves are given in IP 474; Asphalt Institute Sampling asphalt products for specification compliance; and, RILEM Methods for sampling hydrocarbon binders.
ANNEX A

IP CLASSIFICATION OF PETROLEUM AND ITS PRODUCTS

A.1 INTRODUCTION

The IP classification of petroleum and its products, set out in Table A.1, is based (except for LPG) on flash points determined by IP 34. The classification system conforms to the most frequently used flash point divisions in pertinent regulations, such as DSEAR.

For petroleum and its products in Classes I, II and III the flash point can be taken as an indication of the lowest temperature at which the product is likely to produce a concentration of vapour that is flammable when in contact with air.

The IP classification indicates flammability hazard, and is applied when selecting precautionary measures against fire (see Section 3) and determining the design, spacing, location and operation of storage installations (see Section 8).

A.2 CUTBACK BITUMENS

Whilst Classes 0 (LPG) and I (e.g. petroleum spirit) will always give rise to a flammable vapour when handled in air, Classes II and III, into which cutback bitumens fall, are further subdivided into Classes II(1) and III(1), and Classes II(2) and III(2), in accordance with the temperature at which they are handled. Those handled below their flash point correspond to subdivision (1), while those handled above their flash point are classified as subdivision (2).

This subdivision of Classes II and III enables an important distinction to be made in the design, spacing, location and operation of their storage and handling facilities: products in Classes II(1) and III(1) require less onerous conditions than those in Classes II(2) and III(2) (see section 8.2). This distinction also affects

<table>
<thead>
<tr>
<th>Product Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>LPG</td>
</tr>
<tr>
<td>I</td>
<td>Liquids that have flash points below 21 °C</td>
</tr>
<tr>
<td>II(1)</td>
<td>Liquids that have flash points from 21 °C up to and including 55 °C, handled below their flash point</td>
</tr>
<tr>
<td>II(2)</td>
<td>Liquids that have flash points from 21 °C up to and including 55 °C, handled at or above their flash point</td>
</tr>
<tr>
<td>III(1)</td>
<td>Liquids that have flash points above 55 °C up to and including 100 °C, handled below their flash point</td>
</tr>
<tr>
<td>III(2)</td>
<td>Liquids that have flash points above 55 °C up to and including 100 °C, handled at or above their flash point</td>
</tr>
<tr>
<td>Unclassified</td>
<td>Liquids that have flash points above 100 °C</td>
</tr>
</tbody>
</table>
the area classification of those facilities and consequent restrictions on the location and type of electrical and non-electrical equipment that can be used locally. See sections 3.4.1, 8.2.1.3, annexes C.4 and C.5.

The testing of cutback bitumens blended with kerosine diluent by IP 34 or its equivalent, shows that, at the normal range of temperature at which they are stored and used, they will fall into Class III(2) and that the vapour produced is likely to be within the flammable range (see section 3.3.1). The control measures set out in sections 8.2.2 and 10.8.1.1 should be applied to avoid the risk of ignition.

It should nevertheless be borne in mind that all petroleum liquids, even at temperatures below that at which a flammable vapour will be formed, when dispersed in a state of very fine subdivision as in mist, spray or foam, can be ignited at temperatures well below the flash point. Thus even for Class II(I) and III(I) products, when mist, spray or foam formation is possible, such as when the product could be released under pressure or a liquid stream impacts a surface close to the point of release, precautions should be taken to avoid local sources of ignition.

**A.3 UNCLASSIFIED BITUMENS AND HEATING OILS BLENDED WITH HEAVY RESIDUAL FRACTIONS**

Paving, hard and oxidised grades of bitumens nominally have flash points greater than 100 °C and therefore fall into the category of Unclassified petroleums. However because of the slow and variable after-reactions which, as outlined in section 3.3.2.2, can occur during storage in heated tankage (giving rise to the evolution of very light flammable vapours), the flash point so determined is not a reliable indicator of the temperature at which the product in a confined space is likely to produce a flammable atmosphere.

The control measures that should be taken to safeguard against such circumstances are described in sections 6.4.1.1, 6.4.1.2 and 8.2.1.3. These include avoiding sources of ignition - electrical and non-electrical - in such tanks or near vents or other openings, except where they have a type of protection suitable for those zoned areas (see annexes C.4 and C.5).

Similar measures should be followed in the case of storage tanks for heavy residual heated fuels (see section 3.5.2) since there can also be a build-up of flammable vapour in the ullage space.
ANNEX B

HANDLING AND STORAGE TEMPERATURES

B.1 INTRODUCTION

Bitumen normally has to be applied hot in order to keep it sufficiently mobile for working. Trying to work at too low a temperature can increase overall risks by adding general handling and operational difficulties.

The principle to be followed is that, in order to minimise the risks from burns, fumes, flammable atmospheres and fire, operations should be carried out at as low a temperature as practicable, compatible with efficient working, and always below the maxima set out here. Following this approach will also help avoid degradation of product quality.

B.2 MAXIMUM HANDLING AND STORAGE TEMPERATURES

The maximum storage and handling temperatures set out in Table B.1 on web page: http://www.energyinst.org.uk/bitumen1 have been established through generally satisfactory operational experience. They can be considered safe, subject to the following appropriate precautions:

— The maximum handling and storage temperatures for cutback grades are well in excess of product flash points. For this reason they can be considered safe only so long as sources of ignition, such as unprotected electrical and non-electrical equipment (see annexes C.4 and C.5), are excluded from the proximity of tank vents (see section 8.2.2.3) and where open air operations are carried out, such as spraying (see section 10.8.1.1).

— For bitumens other than cutback grades, the maximum handling and storage temperatures are below their notional flash points, but at these temperatures there are risks that pyrophoric deposits or other sources of ignition might be present in some tank ullage spaces in which evolution of flammable vapour may accumulate. See section 3.4.5.

For this reason, the storage guidance given in sections 8.4.7 and 10.2.2 should be followed together with the design and operational guidance for ensuring accurate temperature control and adequate cover of heating elements in sections 8.3.2 and 8.4.3. The area classification guidance in sections 8.2.1.3 and 8.2.2.3 should also be adhered to, in respect both of unprotected electrical and non-electrical equipment in the proximity of tank vents and other openings.

B.3 PUMPING TEMPERATURES

Table B.1 on web page: http://www.energyinst.org.uk/bitumen1 provides the minimum temperatures required for pumping liquid bitumens. For normal pumping operations, temperatures 10 to 50 °C in excess of these may be more appropriate.

1The tables are given by reference to a web page that is regularly updated rather than by being included in this Code because, with the replacement of British Standards by harmonised European Standards, those details are changing.
B.4 BULK LOADING TEMPERATURES

To achieve reasonable loading rates, temperatures 40 to 50 °C above the minimum pumping temperature may be necessary. The maximum storage and handling temperatures shown in Table B.1 on web page: http://www.energyinst.org.uk/bitumen should not be exceeded.

B.5 MIXING TEMPERATURES

The temperatures typically required for mixing bitumens with aggregates or fillers are set out in Table B.1 on web page: http://www.energyinst.org.uk/bitumen. These illustrate that in some cases working temperatures have to approach closely the maxima. Mixing temperature should be carefully controlled to ensure a safe operation.

B.6 SPRAYING TEMPERATURES

The viscosity required for spraying depends upon the type of spray head used. Viscosities of 30-50 cSt are required for swirling jets and 60-90 cSt for slotted jets. See section 10.8.1.3.

B.7 KETTLE WORKING TEMPERATURES

Kettle working temperatures should be kept as low as reasonably practicable and should not normally be allowed to exceed the maxima given in Table B.1 on web page: http://www.energyinst.org.uk/bitumen. For roofing with RBMs, temperatures at the point of application need to allow for the expected cooling between kettle and point of application, especially when working in winter. Refer to pertinent user standards (see section 10.4.2).

When working at or near these temperatures, there should be good ventilation to avoid fume and fire hazards. There should be careful temperature control and particular attention is necessary to fire-fighting precautions.

B.8 ROAD TANKER AND RAIL WAGON TANK TEMPERATURES

When heating road tankers and rail wagon tanks, there should be good temperature control to ensure that temperatures do not exceed the maxima given in Table B.1 on web page: http://www.energyinst.org.uk/bitumen and care is necessary to control local sources of ignition. See section 9.8.6.
ANNEX C

AREA CLASSIFICATION

C.1 INTRODUCTION

Vapours derived from bitumen handling and use may form flammable atmospheres that are susceptible to ignition from local ordinary type electrical and non-electrical industrial equipment (e.g. lighting, switches, motors, heating and measuring instruments), because of the arcs, sparks and hot surfaces that they produce. This is particularly valid for vents to the confined ullage space of heated bitumen storage tanks where flammable atmospheres are usually present.

Ideally, ordinary-type electrical and non-electrical equipment should only be installed in ‘safe’ areas remote from a location in which a flammable atmosphere can arise, but often this is not reasonably practicable and alternative control measures are required. Area classification provides a protocol for recognising the possibility of forming flammable atmospheres and controlling potential sources of ignition.

The approach of area classification is firstly to nominally divide installations into hazardous and non-hazardous areas, and to further sub-divide hazardous areas into zones, based on the likely presence and duration of a flammable atmosphere. This approach is consistent with DSEAR.

The second aspect of area classification is to control sources of ignition, such as fixed and mobile electrical equipment and hot surfaces, to reduce to an acceptable level the probability of their coincidence with a flammable atmosphere.

Note that it is not the aim of area classification to address major releases of flammable products following catastrophic failure (e.g. rupture of a storage vessel), and to guard against their ignition: the frequency of such releases should be minimised by adequate design, construction, operation, inspection and maintenance.

C.2 HAZARDOUS AREAS AND ZONES

IP Area classification code for installations handling flammable fluids, which conforms to the internationally recognised concepts set out in IEC 60079/10, subdivides hazardous areas into zones:

- Zone 0: That part of a hazardous area in which a flammable atmosphere is continuously present or present for long periods;
- Zone 1: That part of a hazardous area in which a flammable atmosphere is likely to occur in normal operation;
- Zone 2: That part of a hazardous area in which a flammable atmosphere is not likely to occur in normal operation, and if it occurs, will only exist for a short period.

It should be noted that the zone number of such hazardous areas is a function solely of the assessed frequency and duration of the flammable atmosphere. All other areas of the installation are therefore, for the purpose of area classification, non-hazardous areas, such that special protection of electrical and non-electrical sources of ignition need not be provided (although other precautions, such as ignition source control areas, may be declared).
C.3 DIMENSIONS OF HAZARDOUS ZONES

While zone number is a function of frequency and duration only of the potential flammable release, the extent (i.e. dimensions) of the zone is a function of the volatility characteristics of the substance, as determined in annex A.1 and the operating conditions of temperature, ventilation etc. See section 3.3. These factors have been incorporated into the storage guidance in sections 8.2.1 and 8.2.2, such that providing that guidance applies and is implemented, the only additional measure should be to select the appropriate type of protection for electrical and non-electrical equipment suitable for operation in the specific zones in accordance with annexes C.4 and C.5. Where there are significant deviations such as layout, Class of product, temperature, pressure or ventilation conditions, the Classification of individual point sources methodology set out in IP Area classification code for installations handling flammable fluids should be applied.

C.4 SELECTION OF APPROPRIATE TYPE OF PROTECTION FOR ELECTRICAL EQUIPMENT IN ACCORDANCE WITH THE HAZARD ZONE NUMBER

Having identified the respective zone number a competent person should select for electrical equipment (including instruments), the pertinent type of protection from the nine internationally recognised types listed in Table C.1.

Table C.1 Standards relevant to electrical equipment for use in hazardous areas

<table>
<thead>
<tr>
<th>Zone</th>
<th>Type of protection</th>
<th>BS EN standard (Note 6)</th>
<th>IEC standard (Note 6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>General requirements</td>
<td>60079/0</td>
<td>60079/0</td>
</tr>
<tr>
<td>-</td>
<td>Data on properties of flammable gases</td>
<td>50014</td>
<td>60079/20</td>
</tr>
<tr>
<td>0</td>
<td>Intrinsically safe Ex ia (Note 2)</td>
<td>60079/25</td>
<td>60079/11</td>
</tr>
<tr>
<td>1</td>
<td>Any explosion protection suitable for Zone 0 and:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Powder filled Ex q</td>
<td>50017</td>
<td>60079/5</td>
</tr>
<tr>
<td></td>
<td>Oil filled Ex o</td>
<td>50015</td>
<td>60079/6</td>
</tr>
<tr>
<td></td>
<td>Flameproof Ex d</td>
<td>60079/1</td>
<td>60079/1</td>
</tr>
<tr>
<td></td>
<td>Intrinsically safe Ex ib (Note 2)</td>
<td>60079/25</td>
<td>60079/11</td>
</tr>
<tr>
<td></td>
<td>Pressurised Ex p</td>
<td>60079/2</td>
<td>60079/2</td>
</tr>
<tr>
<td></td>
<td>Increased safety Ex e</td>
<td>60079/7</td>
<td>60079/7</td>
</tr>
<tr>
<td></td>
<td>Encapsulated Ex m</td>
<td>60079/18</td>
<td>60079/18</td>
</tr>
<tr>
<td>2</td>
<td>Any explosion protection suitable for Zone 0 or 1 and:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non-incendive Ex n</td>
<td>60079/15</td>
<td>60079/14, 60079/15</td>
</tr>
</tbody>
</table>

Notes:
1. These details have been condensed from IP Area classification code for installations handling flammable fluids.
2. Intrinsic safety protection is at two levels: Ex ia and Ex ib. Only type Ex ia being certifiable for Zone 0 installation.
3. Equipment type of protection 'special protection' / marking latter 's' equipment is no longer applicable; however, ATEX equipment category II 1 G is appropriate, i.e. meeting the requirements of IEC 60079-26 or EN 50284.
4. Equipment with types of protection given in Table C.1 are designated as Group IIG, being suitable for above ground usage in flammable atmospheres. (Group I apparatus is specifically for mining application and Group IID for where dusts are present.) Some Group II types are further subdivided in order of different flammable vapour minimum ignition energy into apparatus sub-groups A, B and C.
5. All types of protected equipment also should fulfil the following further requirements:
   — Equipment should be assigned an appropriate Temperature class (T1 to T6), listed in ascending order of severity, and chosen to ensure that the surface temperatures attained by the apparatus, both internal and external (i.e. the casing), will at its full rating not exceed the ignition temperature of the gas or vapour that will be encountered.
   — The required degrees of environmental protection, against access into the equipment of a) foreign objects such as dust, tools etc., or parts of the body; b) the ingress of fluids including rain, water jets etc. is described in IP Electrical safety code.
6. For references to relevant standards, see IP Area classification code for installations handling flammable fluids.
Correct equipment selection requires four factors to be taken into account:

— the zone number in which the equipment will be used;
— the sensitivity to ignition of the gases or vapours likely to be present, expressed as a gas group;
— the sensitivity to ignition of the gases or vapours likely to be present to hot surfaces, expressed as a temperature classification.
— the degree of environmental (mechanical) protection.

The approach is to select for the pertinent hazardous areas the most secure level of equipment and protective system protection that complies with the requirements of Equipment and Protective Systems for use in Potentially Explosive Atmospheres Regulations (EPSR). Under those regulations, equipment and protective systems for use in particular zones are assigned to three categories:

— Category 1: equipment providing the most secure level of protection and suitable for use in Zones 0, 1, or 2;
— Category 2: equipment providing an intermediate level of protection and suitable for use in Zones 1, or 2;
— Category 3: equipment providing the least secure level of protection and suitable for use only in Zone 2

The combined effect of EPSR and DSEAR is to require 'new' equipment to meet the essential health and safety requirements set out in the former and therefore be 'CE' marked and carry the explosion protection symbol 'Ex' in a hexagon. For further requirements regarding 'existing' equipment and 'existing' workplaces, see HSC Dangerous substances and explosive atmospheres.

For the vapours released from heated bitumens an apparatus sub-group IIA and a temperature class T2 (maximum surface temperature 300 °C) are typical, while for cutback grades with kerosine diluent an apparatus subgroup IIA with temperature class T3 (maximum surface temperature 200 °C) should be considered.

For further guidance, see IP Area classification code for installations handling flammable fluids and IP Electrical safety code for references to relevant standards, certification and marking of such apparatus, installation, maintenance, inspection, etc.

C.5 SELECTION OF APPROPRIATE TYPE OF PROTECTION FOR NON-ELECTRICAL EQUIPMENT IN ACCORDANCE WITH THE HAZARD ZONE NUMBER

As well as selecting appropriate electrical equipment for use in each hazardous zone, a competent person should similarly select suitably protected non-electrical equipment that might otherwise be capable of being a source of ignition. These may comprise naked flames in directly fired furnaces, vehicles, hot surfaces on compressors or any equipment that may cause friction sparks. An approach analogous to that set out in annex C.4 should be applied to enable consistency with the requirements of EPSR.

European standards for protection of non-electrical equipment are being developed, analogous to those set out in Table C.1. These will categorise and assign temperature classes to equipment such that it should only be used in appropriate zones. Further guidance is provided in IP Area classification code for installations handling flammable fluids.
BITUMEN SAFETY CODE
ANNEX D

GLOSSARY OF TERMS AND ABBREVIATIONS

For the purpose of these Guidelines, the interpretations in Table D.1 and Table D.2 apply, irrespective of any meaning the words may have in other connections.

D.1 GLOSSARY OF TERMS

Additive: any substance that is added in small proportions to bitumen to impart some particular property e.g. improved adhesion, emulsification etc.

Air-line fed RPE: RPE with a hood, helmet or loose fitting face-piece, that provides the wearer with breathable air supplied by compressed air-line, that has been drawn from a distant source that is free of hazardous substances. See Respiratory protective equipment.

Anti-foam agent: a substance, e.g. silicone oil, which when added to a bitumen will reduce the surface tension and hence the frothing tendency of hot bitumen in the presence of water.

Approved eye protection: goggles, visors, spectacles or fixed shields that meet the requirements of a relevant standard.

Area classification: the notional division of an installation into hazardous areas and non-hazardous areas, and the sub-division of hazardous areas into zones. See hazardous area, non-hazardous area, and zone.

Asphalt: a mixture of mineral aggregate and a bituminous binder. The term is normally qualified by an indication of the origin or type, e.g. Trinidad lake asphalt, rolled asphalt, mastic asphalt.

Atactic polypropylene (APP): a polymer modifier.

Auto-ignition: ignition that results from heating of a substance in the absence of a source of ignition when exposed to an atmosphere containing oxygen.

Auto-ignition temperature: see ignition temperature.

Barrier cream: a non-dermatitic cream or ointment which, when applied to the skin, gives some protection against contamination and facilitates subsequent cleansing with soap and water.

Bioavailable: how metabolically available a substance becomes to the target tissue after it is introduced into a person’s body.

(Bituminous) binder: an adhesive material containing bitumen.

Bitumen: a virtually involatile, adhesive and waterproofing material derived from crude petroleum, or present in natural asphalt, which is completely or nearly completely soluble in toluene, and very viscous or near solid at ambient temperatures.

Bitumen emulsion: a dispersion of bitumen in water achieved by the use of suitable chemical emulsification agent additives.
**Blending**: a process used to produce a product with different physical properties from each component.

**Blowing flux**: a heavy petroleum liquid that is added to a bitumen to facilitate the production of oxidised grades. See also *flux*.

**Blown bitumen**: see *oxidised grade bitumen*.

**Boil-over**: the rapid increase in volume caused by the presence of water in hot bitumen and the subsequent overflow from a tank. See *froth-over* and *slop-over*.

**Bund**: secondary containment in the form of a compound around a tank (the primary containment), capable of retaining a spillage from the tank or immediately associated pipework, or for retaining firefighting water. See *impervious bund*.

**Carcinogenic**: capable of causing cancer.

**Classification of petroleum**: the IP system for assigning classes to petroleum and its products based on their flash points.

**Cold work**: work using tools or equipment that will not cause ignition of any flammable atmosphere present, and work carried out under control to limit the heat produced such that the temperature of the tools or equipment does not exceed 100 °C. See *hot work*.

**Combustible**: a substance not falling into the flammable classification as such, but capable of self-sustained burning in air, once ignited. See *flammable*.

**Competent inspector**: a person having the necessary knowledge, experience and authority to carry out and witness the required inspection and testing of plant, equipment or operations and to assess and certify the results of such inspection and testing.

**Competent person**: a person having suitable qualifications, experience and authority to adequately carry out a designated task.

**Confined space**: a confined space is a place such as a chamber, tank, pit, pipe, etc., which is substantially enclosed (though not always entirely), and where there arises a reasonably foreseeable specified risk where serious injury can occur from hazardous substances or conditions within the space or nearby (e.g. through lack of oxygen).

**Creosote**: a coal tar fraction boiling mainly between 200 °C and 350 °C. In the past, it has been used as a diluent in certain special cutback bitumens.

**Cutback bitumen**: bitumen, whose viscosity has been reduced by the addition of a relatively volatile flux such as kerosine, to increase its mobility for ease of application.

**Diffuser nozzle**: an adjustable fire-fighting nozzle that is capable of converting a stream of water into fine spray.

**Diluent**: a fluid, such as kerosine, added to reduce the viscosity of bitumen.

**Emergency response team**: a group employed or contracted to implement fire safety emergency plans and to take initial action to protect property using fire-fighting equipment.

**Emulsification agent**: additives used to disperse bitumen in a liquid in which it is not soluble.

**Explosive atmosphere**: a mixture of flammable gases or vapours with air in such proportion that, after ignition, combustion rapidly spreads to the entire unburned mixture and congestion or confinement leads to generation of over-pressure. This is a special case of a flammable atmosphere. Note, DSEAR uses the term explosive atmosphere whether there is flammable or flammable and explosive potential. See *flammable atmosphere*.

**Explosive limits**: see *flammable limits*.

**Fire-fighting foam**: foam for fire-fighting is produced from water and chemicals, usually with mechanical aspiration, and is applied to the burning zone to exclude oxygen by blanketing of the surface.

**Flame tube heater**: means of heating bitumen, normally applicable to smaller sized vessels or tanks. It consists of an oil or gas fired burner associated with a flue pipe immersed in the product to be heated.

**Flammable (synonymous with inflammable)**: a combustible substance, solid, liquid, gas, vapour, mist, spray or foam that is easily ignited in air. See *combustible*.

**Flammable atmosphere**: a mixture of flammable gas or vapour with air in such proportion that, without any
Flammable limits: the upper and lower limits of concentration of a flammable gas or vapour in air within which the mixture will burn when ignited. These are referred to as the upper flammable limit (UFL) and the lower flammable limit (LFL) respectively. They are sometimes referred to as explosive limits, i.e. UEL and LEL respectively.

Flammable range: the range of gas or vapour concentrations between the flammable limits.

Flash point: the lowest temperature, corrected to a barometric pressure of 101.3 kPa, at which the application of a source of ignition in a prescribed manner causes the vapour of a test portion to ignite and the flame propagates across the surface of the test sample under the specified test conditions. Flash points are dependent on various factors, including the test method used. Test methods typically applied to bitumen products are IP 34 or an equivalent closed cup method, or IP 36 or an equivalent open cup method.

Flux (oil): see diluent and blowing flux.

Foam: a collection of bubbles of air or gas formed in a liquid. See anti-foam agent, and fire-fighting foam.

Froth-over: spilling over a tank rim caused by the evaporation of water droplets within a hot bitumen mass producing an eruption of froth. See boil-over and slop-over.

Fume: vapour carrying suspended solid particles or liquid droplets.

Gantry: a fixed structure providing access to the top of a road tanker or rail wagon for loading or unloading operations.

Gas detector: an instrument, fixed or portable, designed to detect the presence and measure the concentration of a flammable atmosphere, gas/vapour hazardous to health (e.g. hydrogen sulphide), or other gas (e.g. oxygen) in an area or confined space.

Gas-free: a confined space or area is considered to be gas-free when the concentrations of flammable and toxic gases or vapours in it are within prescribed safe limits, and the oxygen content is sufficient to sustain the respiration of personnel. Gas-free status only applies at the time of satisfactory testing; for continuing gas-free status, the area or enclosed space should be protected against ingress of flammable and toxic gases or vapours and there should be no activities within the confined space or area that could release flammable or toxic gases. See confined space and gas detector.

Hard industrial grade bitumens: hard bitumens are supplied to specification BS EN 13305. They are manufactured in a similar way to paving grade bitumens but they have lower penetration values and higher softening points. British Standard grades are normally designated by the prefix 'H' followed by two numbers representing the limits of the softening point range.

Hard paving grade bitumens: hard bitumens supplied to specification EN 13924 used in road construction and maintenance, e.g. for high modulus asphalts.

Hazard: the potential for human injury or adverse health, damage to property, or environmental impact. See risk.

Hazardous area: a three-dimensional space in which a flammable atmosphere is or may be expected to be present at such a frequency as to require special precautions with the use of potential sources of ignition within it. Hazardous areas are further subdivided into zones. See non-hazardous area, flammable atmosphere and zones.

Hazard radius: the largest horizontal extent of a hazardous area that is generated by a source of release when situated in an open area under unrestricted natural ventilation.

Hazard warning panel: a means of displaying generic information on a road tanker or rail wagon carrying dangerous goods about the product identity, hazards and emergency action, including contact details for obtaining further information.

Hazardous atmosphere: (synonymous with flammable atmosphere). Note, in this context the term does not refer to the possibility of that atmosphere also being toxic.

Head space: see ullage space.

Hot work: work involving flames or equipment that might cause ignition of any flammable atmosphere present. Hot work includes welding, the use of any flame or electric arc, any equipment likely to cause heat, flame or spark, such as drilling, caulking, chipping, riveting, and any other such heat-producing operation.
unless it is carried out in such a way as to keep the temperature below the level at which ignition of a flammable atmosphere could occur (typically 100 °C). See cold work.

Ignition source: see source of ignition.

Ignition source control area: a general area that may contain several hazardous areas and some non-hazardous areas in which hot work is controlled by a PTW. See hazardous area and non-hazardous area.

Ignition temperature: (synonymous with auto-ignition temperature, spontaneous ignition temperature and self-ignition temperature.) The lowest temperature at which a substance, when exposed to air, ignites in the absence of a source of ignition under specified test conditions. Typically, ignition may result from contact of a flammable substance with a hot surface or by self-heating alone. See flash point and self-heating.

Impervious bund: secondary containment comprising an area where the floor and walls of the bund are impermeable to the products stored in the primary containment system (e.g. a tank and immediately associated pipework). See bund.

Incandescent: glowing with heat.

Inert gas: a gas or mixture of gases that do not support combustion.

Inflammable: see flammable.

IP: formerly The Institute of Petroleum; the successor body being the Energy Institute. The term is used for numbered publications, e.g. IP 34, and for classifying petroleum and its products. See classification of petroleum.

Local exhaust ventilation (LEV): artificial ventilation, typically used as a control measure to reduce personnel exposure to hazardous substances. This includes permanently installed plant and portable units. See ventilation.

Loss on heating: the percentage loss of mass and the percentage drop in penetration value, as measured after heating a bitumen for five hours at 163 °C by IP 45.

Lower explosive limit (LEL): see flammable limits.

Lower flammable limit (LFL): see flammable limits.

Mastic asphalt: blends of paving or hard grade bitumens with finely ground mineral fillers.

Material safety data sheet (MSDS): a document provided by the supplier to the purchaser of a hazardous substance that sets out product hazards, and precautions in its handling, storage, use and disposal.

Maximum exposure limit (MEL): the hazardous substance concentration in the working atmosphere annually set, by the Health and Safety Executive, as a limit that should not be exceeded under any circumstances. The limits are normally set as Long Term Exposure Limits (8 hour time weighted average (TWA) values) and/or as Short Term Exposure Limits (STEL) (15 minute TWA values).

MoT test: a test of vehicle roadworthiness in specific categories, with the certificate being issued under the auspices of the Department for Transport (formerly the Ministry of Transport).

Non-flammable: a substance that is not easily ignited. However, this does not necessarily indicate that it is non-combustible. See flammable and combustible.

Non-hazardous area: a three-dimensional space in which a flammable atmosphere is not expected to be present so that special precautions are not required for the use of potential sources of ignition, such as electrical and non-electrical apparatus. However, a non-hazardous area may be part of a wider ignition source control area. See hazardous area and ignition source control area.

Occupational exposure limit (OEL): the hazardous substance concentration in the working atmosphere annually set, by the Health and Safety Executive, as either an OES or MEL. See OES and MEL. Note OELs are being replaced by Workplace Exposure Limits (WELs).

Occupational exposure standard (OES): the hazardous substance concentration in the working atmosphere annually set, by the Health and Safety Executive, either as a standard that should not normally be exceeded, or as a standard of good practice. OESs are normally set as Long Term Exposure Limits (8 hour time weighted average (TWA) values) and/or as Short Term Exposure Limits (STEL) (15 minute TWA values). Countries other than the UK have similar standards.
Occupational fire brigade: a group wholly funded by
a body other than a statutory fire authority, maintained
for the purposes of saving life and protecting property
in the event of a fire or other emergency in locations
owned, managed or occupied by the sponsor. An
occupational fire brigade may be employed by the
sponsor or contracted from an external competent
organisation.

Orinasal respirator: half-face RPE that supplies the
wearer with breathable air that has been drawn from the
immediate environment through filters selected for the
particular hazardous substances. See respiratory
protective equipment.

Oxidised grade bitumen: grades produced by passing
air through soft bitumen/flux mixtures under controlled
temperature conditions. British Standard grades are
normally designated by two numbers representing the
mid-points of their softening point and penetration
ranges.

Paving grade bitumens: bitumen used to coat mineral
aggregate for use in the construction and maintenance
of paved surfaces. They are usually produced by
vacuum distillation of petroleum, followed in some
cases by an oxidation process. British Standard grades are
normally designated by two numbers representing the
penetration range separated by a forward slash and the
suffix ‘pen’.

Penetration grade bitumens: a description used in
BS 3690 up to the year 2001, but replaced by the term
paving grade bitumens. See paving grade bitumens.

Penetration value: a measure of the consistency of
bitumen, determined as the depth to which a standard
needle penetrates the sample under the conditions
prescribed by IP 49 or equivalent.

Permit to work (PTW): a document issued by an
authorised person permitting specific work to be carried
out in a defined area during a stated period, provided
that specified safety precautions are taken.

Personal protective equipment (PPE): equipment
such as protective clothing, heat-resistant heavy-duty
boots, face and eye shields, provided where required by
risk assessment by employers to their employees, to
prevent exposure. See respiratory protective equipment
and approved eye protection.

Petroleum class: see Classification of petroleum.

Polycyclic aromatic hydrocarbons (PAHs): (synonymous with Polycyclic aromatics (PCA) and
Polynuclear aromatics (PNA)). High boiling point
members of a family of aromatic hydrocarbons present
in low concentrations in bitumens.

Polymer-modified bitumens: these usually consist of
a paving grade bitumen into which is added a proportion
of organic polymer (e.g. EVA or SBS block
copolymers). The polymer enhances certain properties
of the bitumen.

Potting hose: a hose terminating in a short piece of
metal pipe, used for delivery or uplifting of bitumen
through an access chamber cover of a tank or vessel.

Powdered, air-purifying respirator: RPE with a hood,
helmet or loose fitting face-piece, that supplies the
wearer with breathable air that has been drawn from the
immediate environment through filters selected for the
particular hazardous substances. See respiratory
protective equipment.

Preparation: a mixture or a solution of two or more
substances (as used in CHIP).

Pyrophoric deposit: a deposit, normally formed in an
oxygen-depleted environment such as within a storage
tank or equipment, that can self-heat when its
temperature or the surrounding oxygen concentration is
increased.

Respiratory Protective Equipment (RPE): PPE used
to protect the wearer from inhalation of particular
hazardous substances and to provide them with
breathable air. There are several types; some provide
protection against specific concentrations of hazardous
substances whereas others provide more general
protection. See air-line fed RPE, self-contained
breathing apparatus, orinasal respirator and powered,
air-purifying respirator.

Risk: the likelihood of human injury or adverse health,
damage to property or damage to the environment from
a specified hazard. See hazard.

Rundown tank: storage tank connected directly to
receive newly produced product from manufacturing
plant.

Secondary containment: an engineering control
measure used to contain fire-fighting water applied to
primary containment or products that are released from
storage in the primary containment. Secondary
containment may be in the form of bunds, lagoons, tanks, diversionary walls or ditches to direct flow to a dispersion or impounding basin, and drip trays. See bund.

**Self-contained breathing apparatus (SCBA):** RPE that supplies the wearer with breathable air, not taken from the immediate environment. See respiratory protective equipment.

**Self-heating:** temperature rise of a substance caused by oxidation of the substance when exposed to an atmosphere containing oxygen.

**Self-ignition temperature:** see ignition temperature.

**Slop-over:** displacement of hot product from a tank during fire-fighting, due to violent evaporation of water beneath the surface. See boil-over and froth-over.

**Snuffing/blanketing steam:** steam that is used to extinguish a fire or to prevent the build-up of a flammable atmosphere. It might be injected into a vessel or tank ullage space or used through a steam lance in the open air.

**Softening point:** the temperature in °C at which a bitumen attains a particular degree of softness with reference to test conditions prescribed by IP 58 or equivalent.

**Soft paving grade bitumen:** paving grade bitumen used in the manufacture of soft asphalts.

**Source of ignition:** (synonymous with ignition source). Accessible source of heat energy, such as naked flames, hot surfaces and certain electrical apparatus, capable of igniting a flammable atmosphere.

**Splash filling:** filling of a storage tank or top loading a road tanker or a rail wagon, where the drop pipe is not inserted vertically to the bottom of the compartment before product flow starts; a charged mist may therefore form.

**Spontaneous ignition temperature:** see ignition temperature.

**Styrene-butadiene-styrene (SBS):** a polymer modifier.

**Transport emergency (TREM) card:** a card carried in the cab of a road tanker or rail train containing generic information about the product identity, hazards and emergency action, including contact details for obtaining further information, and action in the event of spillage, fire, or personnel requiring first-aid.

**Type of protection:** measures applied in the construction of electrical and non-electrical equipment to prevent ignition when that equipment is used in a flammable atmosphere.

**Ullage space:** (synonymous with head space and vapour space). The space above the liquid level in a tank.

**Upper explosive limit (UEL):** see flammable limits.

**Upper flammable limit (UFL):** see flammable limits.

**Vapour space:** see ullage space.

**Ventilation:** air movement and replacement by fresh air. Natural ventilation refers to ventilation caused by wind or convection, whereas artificial ventilation refers to ventilation caused by air purge or mechanical means such as fans. See local exhaust ventilation.

**Viscosity:** a measure of the resistance of a fluid to flow. Various scales of measurement are used. The STV is used in IP 72 to characterise cutback bitumens in seconds. Kinematic viscosity is a derived characteristic that can be used to represent the fluid in technical calculations.

**Workplace exposure limit (WEL):** see occupational exposure limit (OEL).

**Zone 0:** that part of a hazardous area in which a flammable atmosphere is continuously present or present for long periods.

**Zone 1:** that part of a hazardous area in which a flammable atmosphere is likely to occur in normal operation.

**Zone 2:** that part of a hazardous area in which a flammable atmosphere is not likely to occur in normal operation and, if it occurs, will exist only for a short period.

### D.2 ABBREVIATIONS

**ADR:** European Agreement concerning the International Carriage of Dangerous Goods by Road (Accord européen relatif au transport international des marchandises dangereuses par route).
APP: atactic polypropylene.
BSM: benzene soluble material.
CCTV: closed circuit television.
CDGUTPER: The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations.
CEN: Comité Européen de Normalisation (European Committee for Standardisation).
CHIP: Chemical (Hazard Information and Packaging for Supply) Regulations.
COMAH: The Control of Major Accident Hazard Regulations.
COSHH: Control of Substances Hazardous to Health Regulations.
DSEAR: Dangerous Substances and Explosive Atmospheres Regulations.
EVA: ethylene vinyl acetate.
FFFP: film-forming fluoroprotein [foam].
FRS: [local government] fire and rescue service.
LAPC: local air pollution control.
LAPP: local air pollution prevention and control.
LEL: lower explosive limit.
LEV: local exhaust ventilation.
LFL: lower flammable limit.
LPG: liquefied petroleum gas.
MEL: maximum exposure limit.
MSDS: material safety data sheet.
OEL: occupational exposure limit.
OES: occupational exposure standard.
PAH: polycyclic aromatic hydrocarbon.
PCA: polycyclic aromatics.
PNA: polynuclear aromatics.
PPE: personal protective equipment.
PTW: permit to work.
RBA: Refined Bitumen Association.
RBM: reinforced bitumen membrane.
RID: Regulations Covering the International Carriage of Dangerous Goods by Rail (Règlement concernant le transport international ferroviaire des marchandises dangereuses).
RPE: respiratory protective equipment.
SBS: styrene-butadiene-styrene.
SCBA: self-contained breathing apparatus.
STV: standard tar viscometer.
TLV: threshold limit value.
TREM card: transport emergency card.
TWA: time-weighted average.
UFL: upper flammable limit.
WEL: workplace exposure limit.
ANNEX E
REFERENCES

The following publications are referred to in this Code:

**American Conference of Governmental Industrial Hygienists (ACGIH)**
ACGIH threshold limit values and biological exposure indices for 2002.

**American Journal of Industrial Medicine**

**American Petroleum Institute (API)**
Std. 2000 Venting atmospheric and low pressure storage tanks.

**Asphalt Institute**
Manual Series No. 18 Sampling asphalt products for specification compliance.

**British Medical Journal (BMJ)**

**British Standards Institution (BSI)**
Note: For test methods and sampling see IP standards.
BS 434/1 Bitumen road emulsions (anionic and cationic). Specification for bitumen road emulsions.
BS 1435/2 Rubber hose assemblies for oil suction and discharge services. Recommendations for storage, testing and use.
BS 1447 Specification for mastic asphalt (limestone fine aggregate) for roads, footways and pavings in building.
BS 1707 Specification for hot binder distributors for road surface dressing.
BS 2594 Specification for carbon steel welded horizontal cylindrical storage tanks.
BS 3690/1 Bitumens for building and civil engineering. Specification for bitumens for road purposes and other panel areas.
BS 3690/2 Bitumens for building and civil engineering. Specification for bitumens for industrial purposes.
BS 3690/3 Bitumens for building and civil engineering. Specification for mixtures of bitumen with pitch, tar and Trinidad lake asphalt.
BS 6130/1 Hose and hose assemblies for asphalt and bitumen. Specification for flexible metallic hose and hose assemblies.
BS 6925 Specification for mastic asphalt for building and civil engineering (limestone aggregate).
BS 8102 Code of practice for protection of structures against water from the ground.
<table>
<thead>
<tr>
<th>Standard Number</th>
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<tr>
<td>BS 8218</td>
<td>Code of practice for mastic asphalt roofing.</td>
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<td>BS EN 149</td>
<td>Respiratory protective devices. Filtering half masks to protect against particles. Requirements, testing, marking.</td>
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<td>BS EN 166</td>
<td>Personal eye protection. Specifications.</td>
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<tr>
<td>BS EN 352/2</td>
<td>Hearing protectors. Safety requirements and testing. Ear-plugs.</td>
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<td>BS EN 388</td>
<td>Protective gloves against mechanical risks.</td>
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<td>BS EN 397</td>
<td>Specification for industrial safety helmets.</td>
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<tr>
<td>BS EN 405</td>
<td>Respiratory protective devices. Valved filtering half masks to protect against gases or gases and particles. Requirements, testing, marking.</td>
</tr>
<tr>
<td>BS EN 420</td>
<td>Protective gloves. General requirements and test methods.</td>
</tr>
<tr>
<td>BS EN 470/1</td>
<td>Protective clothing for use in welding and allied processes. General requirements.</td>
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<tr>
<td>BS EN 471</td>
<td>High-visibility warning clothing for professional use. Test methods and requirements.</td>
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<tr>
<td>BS EN 531</td>
<td>Protective clothing for workers exposed to heat.</td>
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<td>BS EN 1765</td>
<td>Rubber hose assemblies for oil suction and discharge services. Specification for the assemblies.</td>
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<tr>
<td>BS EN 1259/1</td>
<td>Bitumen and bituminous binders. Specification for paving grade bitumens.</td>
</tr>
<tr>
<td>BS EN 13304</td>
<td>Bitumen and bituminous binders. Framework for specification of oxidised bitumens.</td>
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<tr>
<td>BS EN 14015</td>
<td>Specification for the design and manufacture of site built, vertical, cylindrical, flat-bottomed, above ground, welded, steel tanks for the storage of liquids at ambient temperature and above.</td>
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<tr>
<td>BS EN 14023</td>
<td>Bitumen and bituminous binders. Specifications for polymer modified bitumen (under development by CEN).</td>
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<td>BS EN ISO 20345</td>
<td>Personal protective equipment. Safety footwear.</td>
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<tr>
<td>BS PD 5500</td>
<td>Specification for unfired fusion welded pressure vessels.</td>
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<tr>
<td>prEN 13924</td>
<td>Bitumen and bituminous binders. Specification of hard paving grade bitumens.</td>
</tr>
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**CONCAWE**


**Department of the Environment, Food and Rural Affairs (DEFRA)**

Guidance note for the Control of Pollution Oil Storage (England) Regulations 2001

Process guidance notes:


**Environment agencies (Environment Agency for England and Wales, Scottish Environment Protection Agency and the Northern Ireland Environment and Heritage Service)**

Pollution prevention guidance notes:

- PPG2 Above-ground oil storage. [link](http://www.environment-agency.gov.uk/ppg).
- PPG18 Managing fire water and major spillages.
- PPG21 Pollution incident response planning.

**Environment Agency**

Control of Pollution Oil Storage (England) Regulations 2001 – Frequently asked questions [link](http://www.environment-agency.gov.uk/osr).

**Eurobitume**

Bitumen burns card. Guidelines for the classification and labelling of bitumens.

Material safety data sheet – paving grade bitumen.

Material safety data sheet – oxidised grade bitumen.

Safe handling of bitumen.
Health and Safety Commission (HSC) (published by HSE Books)
Dangerous Substances and Explosive Atmospheres – Approved Code of Practice and Guidance.

Health and Safety Executive (HSE) (published by HSE Books)
EH40 Occupational exposure limits.
HS(G)250 Guidance on permit-to-work systems: A guide for the petroleum, chemical and allied industries.
HS(G)186 The bulk transfer of dangerous liquids and gases between ship and shore.
Approved carriage list: Information approved for the carriage of dangerous goods by road and rail other than explosives and radioactive material.
INDG214 First aid at work: Your questions answered.

Her Majesty’s Stationery Office (HMSO)
Control of Substances Hazardous to Health Regulations 2004 (SI 2004/1657).
The Control of Major Accident Hazard Regulations 1999 (SI 1999/743).
The Control of Major Accident Hazards (Amendment) Regulations 2005 (SI 2005/1088).
Environmental Protection Act 1990 (1990 section 43).
The Control of Pollution (Oil Storage) (England) Regulations 2001 (SI 2001/2954).

IP (published by Energy Institute)
Standards for testing and sampling
— IP 34 Determination of flash point – Pensky-Martens closed cup method. (Technically identical to BS 2000/34, BS EN ISO 2719.)
— IP 36 Determination of flash and fire points – Cleveland open cup method. (Technically identical to BS 2000/36, BS EN ISO 2592.)
— IP 49 Methods of test for petroleum and its products. Bitumen and bituminous binders. Determination of needle penetration. (Technically identical to BS 2000/49, BS EN 1426.)
— IP 58 Methods of test for petroleum and its products. Bitumen and bituminous binders. Determination of softening point. Ring and ball method. (Technically identical to BS 2000/58, BS EN 1427.)
— IP 222 Methods of test for petroleum and its products. Bitumen and bituminous binders. Determination of dynamic viscosity by vacuum capillary. (Technically identical to BS 2000/222, BS EN 12596.)
— IP 319 Methods of test for petroleum and its products. Bitumen and bituminous binders. Determination of kinematic viscosity. (Technically identical to BS 2000/319, BS EN 12595.)
— IP 460 part 1 Methods of test for petroleum and its products. Bitumen and bituminous binders. Determination of the resistance to hardening under the influence of heat and air. RTFOT method. (Technically identical to BS 2000/460.1, BS EN 12607/1.)
— IP 460 part 2 Methods of test for petroleum and its products. Bitumen and bituminous binders. Determination of the resistance to hardening under the influence of heat and air. TFOT Method. (Technically identical to BS 2000/460.2, BS EN 12607/2.)
— IP 460 part 3 Methods of test for petroleum and its products. Bitumen and bituminous binders. Determination of the resistance to hardening under the influence of heat and air. RFT Method. (Technically identical to BS 2000/460.3, BS EN 12607/3.)
— IP 474 Bitumen and bituminous binders – Sampling bituminous binders. (Technically identical to BS 2000/474, BS EN 58.)
— IP 502 Methods of test for petroleum and its products. Bitumen and bituminous binders. Determination of the efflux time of petroleum cut-back and fluxed bitumens (Technically identical to BS 2000/502, BS EN 13357.)

— IP 506 Methods of test for petroleum and its products. Bitumen and bituminous binders. Determination of the loss in mass after heating of industrial bitumens. (Technically identical to BS 2000/506, BS EN 13303.)


Model codes of safe practice in the petroleum industry:
— Part 1 Electrical safety code.
— Part 2 Design, construction and operation of petroleum distribution installations.
— Part 15 Area classification code for installations handling flammable fluids.
— Part 16 Tank cleaning.
— Part 19 Fire precautions at refineries and bulk storage installations.

Other guidance:
— Code of practice for a product identification system for petroleum products.
— Code of practice for drivers’ emergency actions on road loading racks.
— Environmental guidelines for petroleum distribution installations.
— Inland waters oil spill response: A guidance document incorporating the strategies and techniques for responding to inland surface water oil spills in the United Kingdom.
— Code of practice for the development of a response plan for significant incidents involving petroleum road tankers.

Technical Paper:
— IP 84-006 IARC Review on bitumen carcinogenicity: Bitumen production, properties and uses in relation to occupational exposures.

International Agency for Research on Cancer (IARC)

International Chamber of Shipping/ Oil Companies International Marine Forum/ International Association of Ports and Harbours (ICS/OCIMF/IAPH)
International safety guide for oil tankers and terminals (ISGOTT).

International Electrotechnical Commission (IEC)
IEC 60079/10 Electrical apparatus for explosive gas atmospheres – Part 10: Classification of hazardous areas.

LP Gas Association (LPGA)
COP 4 Safe and satisfactory operation of propane-fired thermoplastic and bitumen boilers, mastic asphalt cauldrons/mixer, hand tools and similar equipment.
COP 7 Storage of full and empty LPG cylinders and cartridges.
COP 10 Containers attached to mobile gas-fired equipment.
COP 25-5 The storage and use of LPG on construction sites.

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Code of practice for the safe delivery of bitumen products.

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Recommendation BM 2 Methods for sampling hydrocarbon binders.

United Nations Economic Commission for Europe (UNECE)
European Agreement concerning the International Carriage of Dangerous Goods by Road. Regulations Covering the International Carriage of Dangerous Goods by Rail.