environmental classification of petroleum substances - summary data and rationale

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ABSTRACT

Environmental data on the fate and effects of petroleum substances are summarised. Technical issues relating to the choice of test methodology for the evaluation of environmental impacts of petroleum substances are discussed. Proposals for self-classification according to EU criteria, as defined in the Dangerous Substances Directive, are presented for individual petroleum substance groups, on the basis of available test data and structure activity relationships (based on composition).

KEYWORDS

Hazard, environment, petroleum substances, classification, aquatic toxicity, biodegradation, bioaccumulation, QSAR, dangerous substances directive.

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CONTENTS

SUMMARY

This report presents available data for the environmental classification of petroleum substances according to EU criteria included in the Dangerous Substances Directive. On a pragmatic basis, the petroleum substances have been assigned to 25 groups for classification purposes. The report includes discussion of methodology for the laboratory evaluation of environmental fate and effects of complex hydrocarbon substances.

The data and recommendations given in this report are primarily intended to assist regulatory personnel in oil industry companies, who are responsible for the environmental classification and labelling of petroleum products.

The fate of petroleum substances in the environment and the nature and limitations of 'real-world' environmental effects data, derived from accidental spills or releases, are discussed in the context of product classification. Recommendations for environmental classification of petroleum substance groups are based on ecotoxicity test data developed using the Water Accommodated Fraction approach. The available test data for each substance group are summarised and the rationale for classification described. For each group, the classification is supported by reference to composition, together with ecotoxicity data and Quantitative Structure Activity Relationship (QSAR) data that are available for the constituent hydrocarbons.

Five major groups of petroleum substances are classified as dangerous for the environment. Test data for three of these groups, the Low Boiling Point Naphthas, Kerosines and Gas Oils indicate that these substances will be toxic to aquatic organisms (symbol N, with R51/53). Test data for the two other groups of petroleum substances, Crude Oils and Heavy Fuel Oils, indicate that these substances will be harmful to aquatic organisms (R52/53).

For ten substance groups (Petroleum Gases, Highly Refined Base Oils, Other Lubricant Base Oils, Paraffin and Hydrocarbon Waxes, Foots Oils, Slack Waxes, Petrolatums, Bitumens, Petroleum Cokes and Other Petroleum Gases), no environmental classification is recommended.

For the remaining ten substance groups, a default recommendation (R53) for environmental classification is proposed. In some instances, aquatic toxicity data may be available for substances within the group which could further modify the environmental classification of the particular substance but cannot be extrapolated to the entire group.

It is particularly noted that certain hydrocarbon solvents have EINECS numbers corresponding to substances included within the Low Boiling Point Naphthas, Kerosines and Gas Oils groups, but these solvents frequently have different compositions from primary refinery streams and environmental test data are often available supporting a different classification.

The enclosed proposals for environmental self-classification are recommended to CONCAWE member companies, taking account of the guidance provided by the EU Working Group on Classification and Labelling for Environmental Effects. The recommendations will be included in the next update of Report No. 98/54, the CONCAWE guidance on the classification and labelling of petroleum substances.

1. REGULATORY FRAMEWORK AND GENERAL INTRODUCTION

The EU Dangerous Substances Directive (DSD) provides a systematic approach for the classification of substances based on a knowledge of their intrinsic properties and in accordance with defined hazard criteria [1]. The 18th Adaptation to Technical Progress (ATP) of the DSD [2] provides the specific criteria for the classification of substances for environmental hazards. Substances which have been reviewed by the European Commission (EC) DG ENV (formerly known as DG XI) Technical Progress Committee (TPC) and classified as dangerous are listed in Annex I to the DSD; this list is periodically updated and published in the Official Journal. The 21st ATP [3] included carcinogenicity and aspiration hazard classification for many petroleum substances. For the other hazardous properties of these substances, along with the hazardous properties of those petroleum substances which were not included in the 21st ATP, the onus is on suppliers to self-classify according to the criteria laid down in the 18th, 22nd [4] and 25th [5] ATPs. The 28th ATP to the DSD [6] includes a consolidated version of Annex VI, commonly known as the classification and labelling guide.

In December 1996, after a series of meetings to discuss the classification of petroleum substances for the aquatic environment, the EC Working Group on Classification and Labelling for Environmental Effects (EWG) decided that it was unable to reach a consensus on the appropriate environmental classification for petroleum substances [7]. The EWG however advised industry to review and update current advice to member companies on environmental classification, to facilitate self-classification of these substances in a formal and coherent way. Both test data and toxicity estimates based upon composition-toxicity relationships should be consistent with the principles discussed and agreed during the EWG meetings; toxicity data developed using the Water Accommodated Fraction approach (see Section 3.1) should be used. The classifications of specific substances should be consistent across industry, and if different classifications for substances described by the same EINECS number were to be proposed (for example for a petroleum stream and a related hydrocarbon solvent), then the scientific rationale for each classification should be thoroughly documented [7]. CONCAWE previously advised member companies on the recommended self-classifications for petroleum substances (including environmental effects) in 1995 and 1998 [8,9]. Since the preparation of the 1998 report, new data relevant to classification (on both health and environmental effects) have been developed (both by CONCAWE and by member companies). Accordingly, there was a need to update the 1998 guidance on classification [10] and to publish this separate report, providing more detailed information on the data for environmental classification. This report includes these new data and provides details of the rationale for the environmental classification of each of the petroleum substance groups. The main aim of this report is to promote consistent self-classification of petroleum substances for environmental hazard throughout Europe.

The hydrocarbon solvents industry, as represented by the CEFIC Hydrocarbon Solvents Producers Association (HSPA), has prepared a separate report [11] on the classification of those petroleum substances that are marketed as hydrocarbon solvents.

2. DATA SELECTION FOR CLASSIFICATION

2.1. WATER "SOLUBILITY" OF PETROLEUM SUBSTANCES AND TEST "CONCENTRATIONS"

Due to their derivation from natural crude oils and the refining processes used in their production, petroleum substances are complex mixtures of hydrocarbons, often of variable composition. Reflecting the properties of the constituent hydrocarbons, they are hydrophobic and exhibit low solubility in water. However, since the individual hydrocarbon components vary considerably in molecular weight or 'carbon number', and also vary in their degree of unsaturation, the individual hydrocarbons exhibit a range of water solubilities. When adding incremental amounts of a complex petroleum substance in water, a point will be reached at which the solubility limit of the least soluble component is exceeded and the remaining components will then partition between the water and the undissolved hydrocarbon phase. As a result, the composition of the total dissolved hydrocarbons will be different from the composition of the parent substance [12,13,14]. Thus, the strict definition of 'water solubility' does not apply to petroleum substances. This water solubility behaviour impacts on both the conduct and interpretation of aquatic toxicity tests for these complex substances, as will be discussed in later sections of this report (see in particular Sections 3.1, 3.2 and 4).

2.2. ACUTE AND CHRONIC TOXICITY AND SOLUBILITY LIMITS

As well as being hydrophobic, hydrocarbons are lipophilic, resulting in high octanol-water partition coefficients (or log K_{ow} values). Hydrocarbons cause toxicity in aquatic organisms by a mechanism referred to as 'non-polar narcosis', or 'general' (non-specific) toxicity [15]. The values of log K_{ow} for individual hydrocarbons increase with increasing carbon number within homologous series of generic types. Substances with the same carbon number show decreasing log K_{ow} values with increasing levels of unsaturation. Quantitative structure activity relationships (QSAR), relating log K_{ow} values of single hydrocarbons to toxicity, show that water solubility decreases more rapidly with increasing K_{ow} than does the concentration causing effects [16,17]. This relationship varies somewhat with species, but it follows that there is a log K_{ow} limit for hydrocarbons, above which they will not exhibit acute toxicity; this limit is at a log K_{ow} value of about 4 to 5 [16,17]. It has been confirmed experimentally that for fish and invertebrates, paraffinic hydrocarbons with a carbon number of 10 or higher (log K_{ow} >5) show no acute toxicity [18] and that alkylbenzenes with a carbon number of 14 or greater (log K_{ow} >5) similarly show no acute toxicity [19]. From these well-demonstrated solubility 'cut-offs' for acute toxicity of hydrocarbon substances, which directly relate to their physico-chemical properties, it is clear that the same should hold for complex petroleum substances. As discussed later, individual components may contribute to the 'total toxicity' of the mixture even if individually, they do not reach a toxic concentration.

QSAR equations for chronic toxicity also suggest that there should be a point where hydrocarbons with high log K_{ow} values become so insoluble in water that they will not cause chronic toxicity, that is, that there is also a solubility cut-off for chronic toxicity [20,21]. Thus, paraffinic hydrocarbons with carbon numbers of greater than 14 (log K_{ow} >7.3) should show no measurable chronic toxicity. The existence of this cut-off for chronic toxicity is supported for petroleum substances by the numerous chronic toxicity studies reported (see later in this document) on lubricant base oils,

which demonstrate that for these substances, composed primarily of alkanes and naphthenes of C_{15} and greater, no evidence of chronic toxicity is seen [22]. Further evidence to support this generalisation is provided by a lack of chronic toxicity for hydrocarbon-based solvents [11].

The criteria for classification of substances as dangerous for the aquatic environment are primarily based upon acute toxicity data in fish, Daphnia and algae and any chronic hazard that they present [2]. However, within the EU classification scheme, there is only limited scope to directly evaluate chronic hazard. Currently, substances which are not rapidly degradable and which are potentially bioaccumulative (BCF > 100 or log K_{ow} > 3) are considered to present a chronic hazard in the aquatic environment and are classified as Dangerous for the Environment. Thus, in the EU scheme, tests for rapid degradability and bioaccumulation become surrogates for chronic toxicity studies to determine classification. This approach has been taken because of the paucity of chronic toxicity data for substances. Although these surrogate classification criteria may inappropriately capture many petroleum substances, classification may be avoided if valid chronic hazard data are available. If, for a sparingly water soluble substance, it can be shown that in a chronic toxicity study (e.g. a 21 day Daphnia test) there is a no-observed effect at 1 mg/l or greater, classification for chronic hazard does not apply.

2.3. PERSISTENCE AND FATE PROCESSES FOR PETROLEUM SUBSTANCES

Biodegradation

Petroleum hydrocarbons are formed by natural processes and through natural crude oil seepages, have been continuously released to the environment for eons. Although man's activities have contributed significantly to environmental releases, hydrocarbons have not accumulated to any significant extent in the natural environment.

Although some low molecular weight hydrocarbons are readily biodegradable in standard OECD tests, as their molecular weight increases, hydrocarbons become decreasingly water-soluble, so that their bioavailability is limited and they are not readily biodegradable in 28-day screening tests. However, hydrocarbons are regarded generally as being inherently biodegradable, although the degradation rates of the more complex high molecular weight hydrocarbons may be very slow.

Abiotic degradation

An important feature of the hazard classification criteria for the aquatic environment is that in referring to fate processes, they describe a substance as being either "readily degradable" or "not readily degradable". This reflects the fact that biodegradation is only one of the possible fate processes for substances in water. Other abiotic degradation processes include hydrolysis and photodegradation.

Hydrolysis is not an important fate process for petroleum substances since hydrocarbons do not undergo reaction with water. However, degradation of unsaturated hydrocarbons, notably aromatic hydrocarbons by reaction with sunlight in the presence of oxygen can be a significant removal process where such substances are present in, or near the surface of water. The current criteria for environmental hazard classification do not address photodegradation.

Volatility

As discussed above, the lower molecular weight hydrocarbon components of petroleum substances (paraffins C_3 to C_9 and alkylbenzenes C_6 to C_{14}) are those which have sufficient water solubility to cause acute toxicity to aquatic organisms. These lighter hydrocarbons are also quite volatile, both in terms of their vapour pressure (which indicates evaporation rate) and Henry's law constant (which influences the rate of volatilisation from aqueous solution) [23]. In order to measure the inherent toxicity of such hydrocarbons, it is necessary to maintain a constant concentration in water for the duration of the test by preventing evaporation. The high volatility of these light hydrocarbons (and the corresponding petroleum substances in which they are found, notably the naphthas and kerosines) requires the use of tightly closed test systems with minimal head-space, both during solution preparation and throughout aquatic toxicity studies. The volatility (and low solubility) of these substances greatly affects the availability and application of methods for the evaluation of biodegradation potential in the laboratory.

In the aquatic environment, the inherent toxicity of these light hydrocarbon constituents is unlikely to be expressed due to their poor water solubility and their rapid volatilisation. The major environmental fate of substances such as the naphthas is rapid evaporation to the atmosphere, followed by rapid atmospheric oxidation (hydroxyl radical attack) [23,24,25]. Releases of petroleum substances comprised of these light hydrocarbons to the surface of water bodies results in a floating layer which spreads on the surface and this is conducive to rapid evaporation rather than dissolution into the water column [26]. Moreover, even if solutions of these light hydrocarbons dissolved in water are released to surface water, the volatilisation half lives are 7 days or less. The only possible circumstance where evaporation of light hydrocarbons might be limited would be following release of a petroleum substance at the bottom of a very deep water body, or under an icecap and both of these are unlikely scenarios. Regardless of the logic of the argument that these light hydrocarbons and corresponding petroleum substances do not persist in the aquatic environment, information on volatility is not currently addressed in the persistence criteria for classification. Moreover, volatility must be prevented in the laboratory assessment of inherent toxicity. The implications of these two factors, with regard to test methodology and classification are discussed in Sections 3.1, 3.3 and 4.

2.4. BIOCONCENTRATION OF PETROLEUM SUBSTANCES

Bioconcentration is the process by which a substance dissolved in water is accumulated by an aquatic organism. Bioconcentration potential is determined by laboratory experiments using standard methods (e.g. OECD 305 test guideline). The test result is expressed as a bioconcentration factor (BCF) which represents the steady-state concentration ratio of the substance in organism tissue (wet, dry or lipid basis) to that in water. Alternatively, in the absence of BCF data, log K_{ow} is often used to conservatively predict bioconcentration potential. However, like water solubility, BCF and log K_{ow} measurements are loading rate dependant for petroleum substances due to the complex composition.

One approach is to estimate an average or weighted value. This approach has been used to characterize the BCF for Jet Fuel in several fish species with reported values ranging from 61-159 on a wet weight basis [27]. However, such an approach has a number of technical shortcomings. First, due to the fact that the composition of the hydrocarbon constituents in the aqueous phase varies in a non-linear fashion

with product loading, the BCF will likewise vary as a function of the petroleum substance loading. Second, differences in analytical methods used to quantify total hydrocarbons introduce significant uncertainties in interpreting results. Lastly, this approach would fail to identify specific constituents that could exhibit a much higher bioconcentration potential than the overall petroleum product mixture.

A more prudent and straightforward approach is to determine the BCF of selected constituents and use these data to evaluate the likely range of BCF values for the constituents of a given petroleum substance. Measured BCF data for fish expressed in terms of parent hydrocarbon are summarized in **Table 1**. BCF data are plotted as a function of Log K_{ow} in **Figure 1**. Different symbols are used to denote the various hydrocarbon classes represented. For comparison, the predictive equation [28]

$$\text{Log BCF} = 0.85 * K_{ow} - 0.70$$

derived principally from data obtained on poorly metabolised substances is also shown plotted as a solid line. Predicted BCFs significantly overestimate measured data for hydrocarbons with Log K_{ow} above 5. This discrepancy is most apparent for PAHs in which a clear inverse relationship between log BCF and log K_{ow} is observed. For other hydrocarbons with log K_{ow} above 5, BCF measurements fall between the PAH data and the above predictive equation. Variation in measured BCF is attributed principally to structural susceptibility of individual hydrocarbon molecules to biotransformation processes as well as species-specific differences in biotransformation capability. Within a given class, branching or alkyl substitution sometimes enhances bioconcentration potential. This effect may be caused by a reduction in the biotransformation rate and/or an increase in the uptake clearance (see below). Many invertebrate species also can metabolise hydrocarbons, although biotransformation may be limited in lower forms such as molluscs [29].

In addition to biotransformation, bioavailability constraints may also limit the bioconcentration potential of hydrocarbons with high log K_{ow}. Complexation to colloidal organic carbon in the test medium can significantly reduce freely dissolved concentrations and hence BCF values for such hydrophobic substances [30]. This effect is expected to be even more pronounced in the field where both dissolved and particulate organic carbon serve to reduce the freely dissolved fraction of these substances.

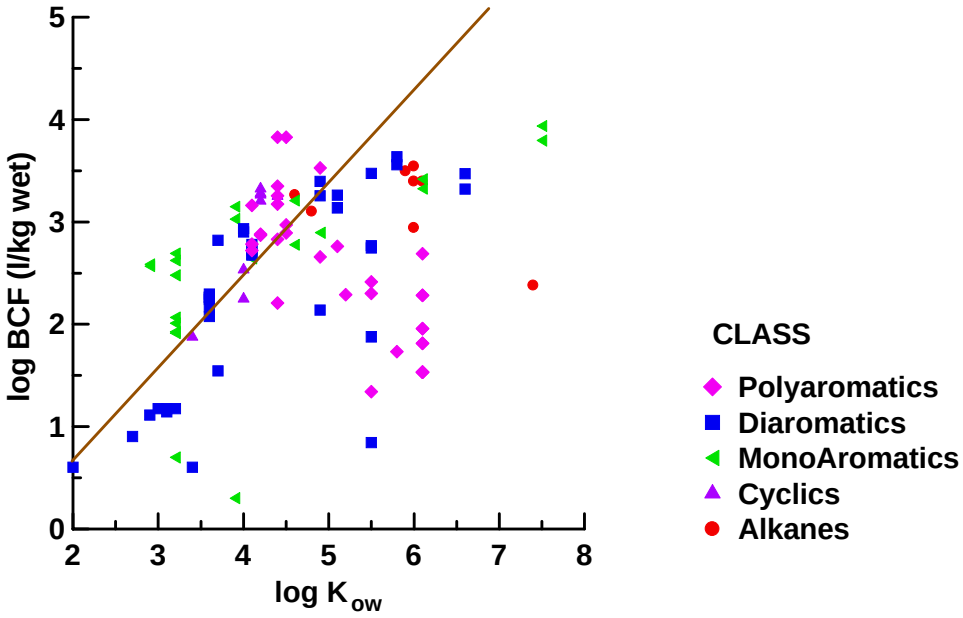
In summary, biotransformation processes generally limit the bioconcentration potential of hydrocarbon constituents. For many products containing high log K_{ow} hydrocarbon components, bioavailability constraints further limit bioconcentration. Due to the biotransformation capability of higher trophic level organisms biomagnification of hydrocarbons in the foodweb is not expected. Lack of biomagnification has been confirmed in both laboratory and field investigations [31,32,33,34,35].

Table 1 Summary of Measured Fish Bioconcentration Factors for Parent Hydrocarbons

Class	Compound	Log K_{ow}	Fish Species	BCF (l/kg wet)	Reference
Alkanes	2,3 dimethylheptane	4.6	rainbow trout	1842	[35]
"	n-nonane	4.8	rainbow trout	1269	[35]
"	Pentamethylheptane	5.9	rainbow trout	3141	[35]
"	2,2,4,6,6 pentamethylheptane	6.0	fathead minnow	880-3500	[36]
"	Dimethyldecane	6.0	rainbow trout	2500	[35]
"	n-dodecane	6.1	rainbow trout	2500	[35]
"	dodecane	7.4	fathead minnow	<240	[36]
Cyclics	Cyclohexane	3.4	carp	31-129	[37]
	Tetrahydronaphthalene	4.0	carp	178-342	[37]
"	Decalin (cis)	4.2	carp	1610-1845	[37]
"	Decalin (trans)	4.2	carp	1905-2110	[37]
"	135 trimecyclohexane	4.4	rainbow trout	1797	[35]
Monoaromatics	benzene	2.0	goldfish	4	[38]
"	toluene	2.7	goldfish	8	[38]
"	styrene	2.9	goldfish	13	[38]
"	Ethyl benzene	3.0	goldfish	15	[38]
"	o-xylene	3.1	goldfish	14	[38]
"	p-xylene	3.1	goldfish	15	[38]
"	m-xylene	3.2	goldfish	15	[38]
"	Methyl styrene	3.4	goldfish	4	[38]
"	1,2,3 timethylbenzene	3.6	carp	175-198	[37]
"	1,2,4 trimethylbenzene	3.6	carp	119-149	[37]
"	1,3,5 trimethylbenzene	3.6	carp	183-185	[37]
"	1,3,5-trimethylbenzene	3.7	rainbow trout	666	[35]
"	isopropyl benzene	3.7	goldfish	35	[38]
"	diphenyl methane	4.0	carp	801	[37]
"	diphenyl methane	4.0	carp	863	[37]
"	m-diethylbenzene	4.1	carp	533-602	[37]
"	p-diethylbenzene	4.1	carp	475-480	[37]
"	biphenyl	4.1	rainbow trout	440	[39]
"	diisopropylbenzene	4.9	carp	1807-2507	[37]
"	diisopropyl benzene	4.9	goldfish	138	[38]
"	phenyl-xylylmethane	5.1	carp	1379-1832	[37]
"	m or p-terphenyl	5.5	carp	76	[37]
"	o-terphenyl	5.5	carp	559-2991	[37]
"	o-terphenyl	5.5	goldfish	589	[38]
"	diethylbiphenyl	5.8	carp	3642-4258	[37]
"	dibenzyltoluene	6.6	carp	2103-2907	[37]

Class	Compound	Log K_{ow}	Fish Species	BCF (l/kg wet)	Reference
Diaromatics	acenaphthylene	2.9	carp	371-385	[37]
"	naphthalene	3.2	carp	85-102	[37]
"	naphthalene	3.2	fathead	302	[40]
"	naphthalene	3.2	rainbow trout	5	[41]
"	naphthalene	3.2	turbot	421	[42]
"	naphthalene	3.2	white mullet	82-492	[43]
"	naphthalene	3.2	bluegill sunfish	300	[30]
"	methylnaphthalene	3.9	rainbow trout	2	[41]
"	methylnaphthalene	3.9	turbot	1071	[42]
"	ethylnaphthalene	3.9	turbot	1416	[42]
"	isopropylnaphthalene	4.6	carp	600-1621	[37]
"	propylnaphthalene	4.9	turbot	787	[42]
"	diisopropylnaphthalene	6.1	carp	2115-2620	[37]
"	triisopropylnaphthalene	7.5	carp	6260-8680	[37]
Polyaromatic	fluorene	4.1	carp	525-609	[37]
"	fluorene	4.1	turbot	1451	[42]
"	acenapthene	4.2	carp	745-762	[37]
"	anthracene	4.4	bluegill sunfish	675	[44]
"	anthracene	4.4	carp	1907-2240	[37]
"	anthracene	4.4	fathead minnow	6761	[40]
"	anthracene	4.4	goldfish	162	[38]
"	dibenzothiophene	4.4	turbot	1495	[42]
"	phenanthrene	4.5	fathead minnow	6761	[40]
"	phenanthrene	4.5	rainbow trout	783	[35]
"	phenanthrene	4.5	turbot	936	[42]
"	fluoranthene	4.9	fathead minnow	3388	[40]
"	pyrene	4.9	goldfish	457	[38]
"	me-phenanthrene	5.1	rainbow trout	579	[35]
"	me-phenanthrene	5.2	turbot	195	[42]
"	benzo(a)anthracene	5.5	fathead minnow	200-260	[40]
"	me-phenanthrene	5.5	turbot	22	[42]
"	chrysene	5.8	turbot	54	[42]
"	benzo(a)pyrene	6.1	gizzard shad	34-193	[45]
"	benzo(a)pyrene	6.1	bluegill sunfish	490	[44]
"	benzo(a)pyrene	6.1	bluegill sunfish	30	[30]

Figure 1 Measured Fish BCFs for Different Hydrocarbon Classes as a Function of the Octanol-Water Partition Coefficient.



3. TEST METHODOLOGY

3.1. AQUATIC TOXICITY TESTING

Current OECD guidelines for the acute aquatic toxicity testing of substances are unsatisfactory when the substances are sparingly soluble in water and/or volatile. However, during 1998, the OECD set up a working group to specifically address the problems of testing these “difficult” substances with the aim of improving the current advice given in its ecotoxicity testing guidelines. The recommendation for complex, sparingly soluble components is to use Water Accommodated Fraction (WAF) and was included in a July 2000 OECD draft guidance document on the aquatic toxicity testing of difficult substances [46].

Test methods are only part of the problem of testing these difficult substances. Further difficulties are encountered in expressing results for aquatic toxicity for sparingly soluble substances, particularly when the substances concerned are complex mixtures. All these difficulties are experienced in dealing with the aquatic toxicity testing of petroleum substances. Some of the problems encountered, and the solutions that have been found, are dealt with in the following paragraphs.

Because of the low water solubility of the hydrocarbon components, adding petroleum substances to water to produce solutions for the evaluation of aquatic toxicity rapidly results in the production of two-phase systems. A number of approaches have been developed to produce ‘media’ for testing, and these have previously been reviewed [47,48]. Many early studies described the preparation of water extracts of petroleum substances at very high loading rates (the term ‘loading’ or ‘loading rate’ has been frequently used as short-hand for the amount of hydrocarbon added to a specific volume of the test medium) [49]. The water extract was then diluted for testing, and the results expressed in terms of the percent dilution of the extract, or alternatively, in terms of the concentration of particular constituent hydrocarbons measured in the water. Data from this type of study, usually referred to as the WSF (Water Soluble Fraction) approach are not useful for classification; the percent dilution result does not fit with the classification criteria defined in terms of mg/l of test substance. Results based upon concentrations of specific dissolved components are again not suitable because the composition of the water fraction produced at a high loading rate will differ considerably from that of a solution prepared at a lower loading rate [12,26,50]. Test methods, based upon varying the loading concentration of the test substance in order to determine the toxicity, produce data more applicable to classification. Often, with petroleum substances composed primarily of low molecular weight hydrocarbons such as the naphthas, nearly all of the substance is dissolved within the loading range where acute toxicity is observed. However, heavier petroleum substances contain a major proportion of components that are not completely soluble. In these cases, there are three methodological options available:

1. Remove the insoluble hydrocarbon portion and evaluate the toxicity of the water phase;

2. Stir the mixture continuously to keep the insoluble material dispersed;

3. Allow the two phases to remain without physical mixing. Approaches 1 and 2 have been most commonly utilised. The disadvantage of the second and third approaches is that the undissolved hydrocarbon may result in physical fouling

and/or entrapment of the organisms, particularly Daphnia and algae; the stirring apparatus used in the second approach may also cause physical harm to such small organisms. The first approach is favoured by CONCAWE, as it precludes physical effects and measures chemical toxicity [51]. The water phase used in this approach is usually known as the Water Accommodated Fraction (WAF), since it is not usually possible to demonstrate that it is a true solution [48]. Toxicity data resulting from these tests are expressed in terms of 'lethal loading' (LL), to distinguish them from the conventional lethal concentration data developed for single substances; the results of lethal loading studies are expressed as LL_{50} or EL_{50} or IL_{50} values, rather than the corresponding LC_{50}, EC_{50} or IC_{50} terms [49]. This method of testing petroleum substances has been recommended for classification and labelling purposes by OECD [46], GESAMP [52], UK DoE [53], CEFIC [54] and CONCAWE [50,51].

The concentration of each individual chemical species dissolved in the water phase at any particular 'loading' must be maximised. The maximum possible water concentration of each component is achieved through prolonged stirring of the water petroleum-substance mixture. In addition, a sealed system approach is necessary to measure the inherent toxicity of the more volatile petroleum substances. Renewal of the WAF may be done daily, or at less frequent intervals, depending on stability.

Chemical analyses of the aqueous concentrations of all constituents are rarely possible due to the complexity of the composition, but equilibration should be confirmed by analysis of selected (representative) hydrocarbons or total dissolved hydrocarbons. Analyses are also typically undertaken to confirm that the concentrations of selected components (and by inference, all components) do not decrease due to volatilisation, or other processes, during the period of exposure. The concentrations of individual hydrocarbons in test media are not needed to calculate the LL_{50} value, since the results are expressed in terms of the entire substance (the concentration used to make the initial WAF).

As a general rule, the use of auxiliary solvents or surfactants in the preparation of media for the testing of petroleum substances is not recommended. The presence of solvents during the preparation of test media from complex substances poses particular problems, as a consequence of their potential to influence partitioning between the dissolved and undissolved phases.

3.2. CALCULATION OF ACUTE TOXICITY FROM COMPOSITION

There are two situations when it may be necessary to estimate the toxicity of a petroleum substance viz. to validate test results and to predict toxicity when data are lacking. This approach requires that the chemical composition of the petroleum substance should be known. In this procedure, the dissolved concentrations of individual hydrocarbons from a petroleum substance are estimated for a given loading rate and then normalised by their acute toxicity to yield Toxic Units (TU) which can be summed to predict the toxicity of the parent material (see below).

As previously described, the quantity of any particular component of a petroleum substance detected in the water phase is related to the loading rate. Theoretically, using closed test systems brought to equilibrium, simple equilibrium partitioning and mass balance calculations may be used to estimate the concentration of each hydrocarbon constituent in water. Clearly such a calculation is only possible for simpler hydrocarbon mixtures since the composition of more complex mixtures cannot be determined. The hydrocarbon/water partition coefficient (K_p) for each of

the components is an essential part of the calculation. The details of this calculation approach have been published [13]. The use of computer spreadsheets greatly facilitates these calculations, and further simplification is obtained by combining the concentration calculations for isomers of particular hydrocarbon species (e.g. iso-hexanes), since all of the isomers have essentially the same values of log K_{ow} and K_p. This procedure is the equivalent of the "hydrocarbon block method" used in the risk assessment of petroleum substances [55,56]. Experimental K_p values [13,14], simply related to K_{ow}, for individual hydrocarbons are available in the published literature.

In order to calculate the joint toxic action of a mixture of hydrocarbons dissolved in water, the concentrations cannot be added directly. Since each component will have a different toxicity, the concentration of each component must be scaled to its toxicity. This is done by division of the concentration by the toxicity (by the LC_{50} in the case of acute toxicity). The resulting values express the concentrations in equivalent "toxic units." Thus, the sum of TUs for the components of a mixture will equal one at the LL_{50} of the mixture. Considerable experimental support for this conceptual framework has been developed, which confirms the fact that the toxicity of mixtures of substances exerting toxicity via a common mechanism, are additive and further, that hydrocarbons act through a common mechanism of non-polar narcosis [56,57].

Toxicity QSARs may be used to provide LC_{50} estimates for hydrocarbons or blocks where acute toxicity data are not available, since these are well established for hydrocarbons (details are included in the EU Technical Guidance Document (TGD) which recommends procedures for risk assessment) [21]. Furthermore, the use of QSAR allows for extrapolation of LC_{50} values to hydrocarbons or blocks that are beyond the solubility ‘cut-off' and have no measured LC_{50} value. This provides a conservative approach for assessing the partial contribution of hydrocarbons or blocks that are individually not expected to exert toxicity.

In summary, given the compositional analysis (together with consideration of the variability of composition of the particular petroleum substance), acute toxicity can be calculated. This toxicity calculation is conservative in that it assumes that each component is maximally dissolved (completely equilibrated with undissolved phase and there is no competition for solubility between similar hydrocarbons) and that there are no losses from solution (due to adsorption to surfaces, absorption to test organisms or volatilisation, etc.). Depending on the QSAR selected, the toxicity calculation may be performed for fish, Daphnia or algae.

Biodegradation Testing Methods

Typically, laboratory studies of the aquatic biodegradability of petroleum substances have evaluated the biodegradation potential of the whole substance, not just the portion which is soluble in water. To achieve adequate sensitivity, most biodegradation tests utilise higher concentrations of substances than would commonly be found in the environment. For a petroleum substance, this means that there will be a large proportion of the substance in the undissolved phase and hence, not available to the degrading organisms. This will result in an underestimate of its true potential to biodegrade in the environment. It is also likely that the rate of biodegradation will be affected; firstly, the rate of biodegradation is likely to be limited by the rate of dissolution and solubility of individual hydrocarbon components. Secondly, the fact that petroleum substances contain a complex mixture of components results in a stepwise, sequential adaptation of the micro-organisms to utilise individual hydrocarbons, again resulting in deviation from

'typical' kinetics. For these reasons, typical logarithmic growth phase (Monod) biodegradation kinetics are not observed with petroleum substances, so that even if individual components are readily biodegraded, the petroleum substance may not achieve the '10-day window' defined by OECD [57].

Some modifications of test methods to enhance dissolution rates may improve this situation. Guidance on approaches to the testing of poorly soluble substances has been published [53]. Experimental methods include ultrasonic dispersion, addition of an inert dispersant or emulsifier to assist in dispersion, or addition of the test substance on an inert support (to increase the surface area and hence aid access of the microorganisms).

Several of the accepted methods for determining biodegradation potential are unsuitable for poorly soluble substances (because they are based on measurement of total dissolved organic carbon) or are unsuitable for volatile substances (because volatile components are lost by evaporation, rather than biodegradation).

Three basic types of biodegradation test are used to estimate the relative biodegradability of substances, viz. ready, inherent and primary biodegradation methods. The use of these procedures in testing petroleum substances is dealt with in the following paragraphs. However, only ready biodegradation data are used for classification.

The principle of using standard laboratory tests to assess biodegradation potential of mixtures has been discussed in an EU workshop [58]; it was agreed that the available methods were suitable for evaluating the biodegradation potential of mixtures comprising homologous series of hydrocarbons (like the petroleum substances), although they were not generally applicable for mixtures.

Ready Biodegradability tests

These are the most stringent of the commonly used laboratory tests, measuring complete mineralisation or Ultimate Biodegradation of the test substance (oxidation to carbon dioxide and water) using an unadapted inoculum over a 28-day period. Ready Biodegradability is defined in terms of the pass/fail criteria agreed for each of the six test methods published by OECD (and subsequently adopted by the EU) [1,59]; in particular, the required level of biodegradation must be obtained within 10 days of 10% biodegradation being achieved. In all the 28-day biodegradation tests, the mineral salts concentration, temperature and pH are tightly controlled, and the microbial inoculum is not allowed to be pre-exposed to the test substance. In addition to the OECD methods, there is a surrogate procedure whereby if the BOD_5:COD ratio is 0.5 or higher, the substance is regarded as being readily biodegradable. Because of the stringency of these test methods, it is presumed that any substance demonstrating Ready Biodegradability will be rapidly biodegraded if released into the aquatic environment.

The Modified Sturm test (OECD 301B) for non-volatile substances and the Respirometric Method (OECD 301F) are the most commonly used methods for petroleum substances.

Inherent Biodegradability tests

These laboratory methods are less stringent than the Ready Biodegradability tests, and hence, increase the likelihood of biodegradation. The extent of complete oxidation of the test substance to carbon dioxide and water is still measured.

Inherent Biodegradability is again defined in terms of the percentage biodegradation recorded in the test; it can be presumed that substances demonstrating Inherent Biodegradability will not persist if released into the aquatic environment. Unfortunately, the currently available Inherent Biodegradation test methods defined by OECD [59] are not suitable for petroleum substances [51]. However, following development and validation of a new Inherent Biodegradation test within ISO [60,61], CONCAWE has recently validated a version of this Headspace Method, adapted to make it more suitable for petroleum substances; the results of this trial have recently been published [62].

Primary Biodegradation tests

Originally developed for evaluating the biodegradability of two-stroke outboard engine lubricants, the CEC L-33-A-93 biodegradation method [63] has been extensively used in the oil industry for assessing the biodegradation potential of a wide range of oil products. The test estimates biodegradation on the basis of a specific change in chemical composition, viz. loss of the parent substance rather than mineralisation. Results obtained using this procedure are of no value for classification purposes.

4. CLASSIFICATION PRINCIPLES

4.1. GENERAL

The EU criteria for the environmental classification of substances are given in **Annex I** of this report.

Petroleum substances comprise a large number of European Inventory of Existing Chemical Substances (EINECS) entries. Many of these substances have overlapping compositions and hence, similar properties. For classification purposes, CONCAWE recommended the allocation of these EINECS entries to a number of distinct groups and this approach was accepted by the Technical Progress Committee (TPC). In developing recommendations for classification for environmental effects, these groupings and combined groups as described by CONCAWE [8] have been maintained in this report. The substance entries in each group are given in **Annexes IIA** and **IIB**. **Annex IIA** lists the entries in each group. **Annex IIB** lists all the substances in Chemical Abstracts Service Registry Number (CAS No)/EINECS No order and identifies the group to which they belong. In general, where differences in composition may lead to differing environmental hazards, a conservative approach has been taken. However, for certain groups the differences in composition are such that a case-by-case classification by the manufacturer of the specific substance is advised. It is further recognised that there are hydrocarbon solvents, produced with narrow boiling ranges, which are considered under the same EINECS entries as the wider boiling range petroleum substances. As a result of their narrow hydrocarbon composition, these solvents may have different aquatic toxicities to those seen with the corresponding petroleum substances. The classification of these solvents is being separately addressed by the Hydrocarbon Solvents Producers Association (HSPA) [11].

Recommendations for the classification of petroleum substances are based upon existing test data. The fact that petroleum substances are complex mixtures and are poorly water soluble has lead to difficulties in conducting aquatic toxicity tests. Many of the data in the published literature are derived from ‘non-standard’ tests. In developing recommendations on environmental classification, criteria for the selection and interpretation of literature data have been developed:

- Aquatic toxicity data from experiments utilising WAFs prepared with known loading rates of substances are preferred;
- In the absence of WAF data, results from tests on fish, or large organisms e.g. shrimp using oil-in-water dispersions;
- For volatile substances, data from sealed system tests which maintained constant concentrations are used.

Most of the selected data have been collected recently, in studies conducted in accordance with OECD guidelines and the principles of good laboratory practice. It was the stated intention of the EU Working Group on Classification and Labelling for Environmental Effects that the petroleum industry should not conduct further testing for classification, but should make use of analogy and QSAR approaches to fill data gaps where possible [7]. This approach has been utilised in this document, but test data have been given priority.

Although petroleum substances are generally not expected to persist in the aquatic environment as a result of their inherent biodegradability (and in some cases volatility), there is a lack of evidence for ready biodegradability. As already discussed in Section 2.4, it is not possible to develop discrete values for log K_{ow} or BCF values for complex mixtures. However, many of the hydrocarbon constituents of petroleum substances have values for log K_{ow} greater than 3. As a result, petroleum substances will be caught by the 'safety net' classification which assigns chronic hazard by the use of risk phrase R53 (May cause long-term adverse effects in the aquatic environment), when they are not acutely toxic, not readily biodegradable, have log K_{ow} greater than 3 and have water solubility less than 1 mg/l. Only evidence of a lack of long-term toxicity can justify their exclusion from this classification.

4.2. GROSS EFFECTS OF PETROLEUM SUBSTANCES

For many petroleum substances, especially those transported in bulk quantities, there is a body of published literature on the adverse effects of accidental releases to marine and fresh water aquatic environments. Although useful in understanding the environmental impacts of spills, such data are of limited value for the purposes of hazard classification. Information on exposure concentrations is seldom adequately quantified and exposure-response relationships are not reproducible.

Clearly, in the event of a spill of a petroleum substance, physical effects may be very important. For example, swimming or diving birds and sea mammals may be coated or entrapped by floating oil, which will also prevent normal gas exchange at the water surface. However, such effects are not unique to the petroleum substances and indeed, they will be observed following spillage of any sparingly soluble liquid with density less than that of water. The EU criteria for environmental hazard classification do not extend to the types of gross effects caused by spillages.

4.3. ALGAL END-POINT

For many years there has been discussion of the most appropriate endpoint for the determination of aquatic toxicity (growth inhibition) in algal species, tested according to OECD Method 201[59]. Typically both the concentrations of test substance (or loading rate) inhibiting growth rate by 50% (IrC_{50} or IrL_{50} value) and that inhibiting biomass production by 50% (IbC_{50} or IbL_{50} value) have been calculated. These two parameters, calculated from a single dataset, often differ (sometimes markedly), but current classification guidelines offer no guidance on which should be used. More recently, within the framework of international harmonisation, the OECD endorsed the use of the growth rate parameter in classification. CEFIC have asked the ECB Environmental Working Group, whether growth rate alone should be used for classification and labelling. The response was that for studies conducted according to the new OECD guideline, exponential growth would be required and therefore only growth rate endpoints would be used. For studies conducted according to the old OECD guideline, but demonstrating exponential growth, all data would be considered according to scientific arguments. Provided that exponential growth occurs, CONCAWE can see no justification for using growth rate alone for new studies and accordingly, throughout this report, where exponential growth is demonstrated, only data for effects on algal growth rate are presented.

4.4. ENVIRONMENTAL SAFETY PHRASES

The environmental safety phrase that is considered to be of most general use for petroleum substances is S61 (*Avoid release to the environment. Refer to special instructions / safety data sheet*). Alternatively, if disposal advice is considered to be very important either S56 (*Dispose of this material and its container to hazardous or special waste disposal point*) or S60 (*This material and its container must be disposed of as hazardous waste*) may be used; S56 is intended for products sold to the general public and S60 is intended for products sold to industry.

Additionally, two other phrases have now acquired an environmental connotation namely, S29 (*Do not empty into drains*) and S35 (*This material and its container must be disposed of in a safe way*). The advice on safety phrases given in Annex VI is that a maximum of four should be used on labels. Also, at least one should be an environmental safety phrase if the substance is classified as Dangerous for the Environment. Further analysis of the criteria shows that this safety phrase is only necessary if the “N” symbol appears on the label. The choice of safety phrases is also influenced by whether the substance is for use by consumers or by industry.

A list of safety phrases and their associated criteria are included in **Annex III** of this report.

4.5. POLYCYCLIC AROMATIC HYDROCARBONS IN PETROLEUM SUBSTANCES

The collective term, polycyclic aromatic hydrocarbons (PAHs) describes a large number of multi-ring aromatic compounds presenting a spectrum of biological activity.

The environmental hazard of certain PAHs has recently been considered by the EWG and the TPC and a small number that are currently included in Annex I of the Dangerous Substances Directive were classified Dangerous for the Environment and assigned risk phrase R50/53 in the recent 24th ATP to the DSD [64].

PAHs are natural constituents of crude oils, where their concentration and chemical types vary. During refining processes, these PAHs will tend to be concentrated in certain petroleum substance streams e.g. aromatic extracts and vacuum distillates. PAHs typically have low water solubilities and log K_{ow} values greater than 3. In the heavier product streams, PAHs tend to be highly alkylated, and to have high molecular weights. When released into the water column, these substances will have limited bioavailability due to the strong partitioning behaviour to organic matter and sediment particles. Many of the substances described in this report contain no PAHs. For others, concentrations of PAHs range from a few parts per million to percentage levels.

For various petroleum streams known to contain a range of concentrations of total PAHs, both acute and chronic aquatic toxicity have been developed; in no case has there been evidence of toxicity associated with the presence of these substances. Chronic toxicity studies (algal and/or *Daphnia*) are available for gas oils, heavy fuel oil streams, lubricant base oils and aromatic extracts.

5. RECOMMENDATIONS FOR ENVIRONMENTAL CLASSIFICATION OF PETROLEUM SUBSTANCE GROUPS

A summary of the available data on the aquatic toxicity (acute and chronic), biodegradability and potential to bioaccumulate is presented in this section of the report, along with the recommended environmental hazard classification for each petroleum substance group. More detailed information on each substance group is presented in **Appendices 1-25** where a more detailed description of the refinery stream included in each group is also given. Each includes typical composition, data on aquatic toxicity, predicted toxicity based on composition, data on biodegradation and bioaccumulation potential and a description of the likely environmental fate of the substance following accidental release.

5.1. CRUDE OILS (Appendix 1)

Experimental studies of acute aquatic toxicity show values for crude oil samples in the range 10 to over 100 mg/l. These values are in accordance with the predicted aquatic toxicity of crude oils based on their hydrocarbon composition. Similar values are obtained whether samples are evaluated as dispersions of the whole oil in water or as WAFs.

Crude oils may not meet the criteria for ready degradability. Hydrocarbon components of crude oils have values for log K_{ow} ranging from less than 3 to greater than 6.

Recommended classification: Dangerous for the environment, no symbol, R52/53.

5.2. PETROLEUM GASES (Appendix 2)

Environmental classification is based on the data for the major components (propane, n-butane and isobutane); these gases have been considered by Environmental Effects Working Group, and it was agreed that they do not meet the criteria for classification as dangerous for the environment. Physical properties indicate that petroleum gases will rapidly evaporate from the aquatic environment and that neither acute, nor chronic toxic effects will be seen in practice.

Recommended classification: No classification for environmental effects.

5.3. LOW BOILING POINT NAPHTHAS (GASOLINES) (Appendix 3)

Experimental studies on low boiling point naphthas, tested in closed systems with minimal head-space, show that acute aquatic toxicity values are greater than 1 mg/l and mostly in the range 1-100 mg/l. These results are in accordance with the predicted aquatic toxicity of these substances based on their hydrocarbon composition. Acute toxicity values for gasolines tested as dispersions of the whole product in water (in semi-enclosed exposure systems), are generally higher than the values recorded for samples tested as WAFs; this is due to volatilisation of some hydrocarbon components.

Gasoline naphthas may not meet the criteria for ready degradability. Hydrocarbon components of naphthas have values for log K_{ow} ranging from 3 to greater than 6.

Recommended classification: Dangerous for the environment; Symbol N with R51/53.

Note: Certain hydrocarbon solvents with EINECS numbers included in this substance group may have compositions and environmental test data supporting a different classification.

5.4. KEROSINES (Appendix 4)

Experimental studies on samples of a range of kerosines, tested in closed systems with minimal head-space, show that acute toxicity values are in the range 1-100 mg/l. These values are in accordance with the predicted aquatic toxicity of these substances based on their hydrocarbon compositions. The acute toxicity value for a kerosine sample tested as a dispersion of whole product in water, was higher (caused effects at higher loading rates) than the values recorded for samples tested as WAFs.

Kerosines may not meet the criteria for ready degradability. Hydrocarbon components of kerosines have values for log K_{ow} ranging from 3.3 to greater than 6. Also, measured BCF values were in the range 61 to 159.

Recommended classification: Dangerous for the environment; Symbol N with R51/53.

Note: Certain hydrocarbon solvents with EINECS numbers included in this substance group may have compositions and environmental test data supporting a different classification.

5.5. GAS OILS (Appendix 5)

Experimental studies on gas oil samples show values for acute aquatic toxicity in the range 1 to over 100 mg/l. These results are in accordance with the predicted aquatic toxicity of these substances based on their hydrocarbon compositions. Acute toxicity values for gas oils tested as dispersions of the whole product in water are similar to those for samples tested as WAFs. This is to be expected since the loss of gas oil components by volatilisation is unlikely to be significant.

Gas oils may not meet the criteria for ready degradability. Hydrocarbon components of gas oils have values for log K_{ow} ranging from 3.9 to greater than 6, although measured BCF values of selected components are <100.

Recommended classification: Dangerous for the environment; Symbol N with R51/53.

Note: Certain hydrocarbon solvents with EINECS numbers included in this substance group may have compositions and environmental test data supporting a different classification.

5.6. HEAVY FUEL OIL COMPONENTS (Appendix 6)

Experimental values for the acute aquatic toxicity of heavy fuel oil samples are in the range 10-100 mg/l. These values are in accordance with the predicted aquatic toxicity of these substances based on their hydrocarbon composition.

Heavy fuel oils may not meet the criteria for ready degradability. Hydrocarbon components of heavy fuel oils have values for log K_{ow} ranging from 2.7 to greater than 6.

Recommended classification: Dangerous for the environment; No symbol, R52/53.

5.7. LUBRICATING GREASES (Appendix 7)

Although limited data on aquatic toxicity indicate that values are greater than 1000 mg/l, there is insufficient information available on the toxicity of the range of thickening agents used in greases to draw general conclusions.

Greases may not meet the criteria for ready degradability. Hydrocarbon components of greases have values for log K_{ow} ranging from 4.5 to greater than 6.

Recommended classification: Dangerous for the environment, no symbol, R53 (unless chronic data justify no classification; other classifications may apply based on acute toxicity data).

5.8. UNREFINED/ACID TREATED OILS (Appendix 8)

There are no experimental aquatic toxicity data for substances in this group and due to the highly variable nature of the substances that they contain, it is not appropriate to draw general conclusions about their likely aquatic toxicity.

Substances in this group may not meet the criteria for ready degradability. Hydrocarbon components of these substances may have values for log K_{ow} ranging from 4.5 to greater than 6.

Recommended classification: Dangerous for the environment, no symbol, R53 (unless chronic data justify no classification; other classifications may apply based on acute toxicity data).

5.9. HIGHLY REFINED BASE OILS (Appendix 9)

Experimental studies of the aquatic toxicity of highly refined base oils and closely related lubricant base oils show that acute toxicity values are greater than 1000 mg/l. These results are in accordance with the predicted aquatic toxicities of these substances based on their hydrocarbon composition. Similar results are seen, irrespective of whether these oils are tested as dispersions of the whole product in water, or as WAFs.

Substances in this group do not meet the criteria for ready degradability. Hydrocarbon components of highly refined base oils have values for log K_{ow} greater than 6. However, the results obtained in chronic toxicity studies with lubricant base

oils as reported in **Appendix 10**, may be read across to highly refined base oils and accordingly, no classification for long-term effects is justified for these substances.

Recommended classification: No classification for environmental effects.

5.10. OTHER LUBRICANT BASE OILS (Appendix 10)

Experimental studies on lubricant base oils show that acute aquatic toxicity values are greater than 1000 mg/l. These results are in accordance with the predicted aquatic toxicity of these substances based on their hydrocarbon composition. Similar results are seen, irrespective of whether these oils are tested as dispersions of the whole product in water or as WAFs.

Substances in this group do not meet the criteria for ready degradability. Hydrocarbon components of highly refined base oils have values for log K_{ow} in the range 3.9 to greater than 6. No Observed Effect Loading Rates in chronic toxicity studies show that such materials do not pose a long-term hazard to the environment.

Recommended classification: No classification for environmental effects.

5.11. RESIDUAL AROMATIC EXTRACTS (Appendix 11)

Experimental data on aquatic toxicity indicate that values for acute toxicity are >1000 mg/l, whilst the No Observed Effect Loading Rate in a study of chronic toxicity was 1000 mg/l. However, due to the potentially variable composition of substances falling within this group, it is not appropriate to draw general conclusions about their chronic aquatic toxicity.

Residual aromatic extracts are not expected to meet the criteria for ready degradability. Hydrocarbon components of these substances have values for log K_{ow} greater than 5.

Recommended classification: Dangerous for the environment, no symbol, R53 (unless chronic data justify no classification; other classifications may apply based on acute toxicity data).

5.12. UNTREATED DISTILLATE AROMATIC EXTRACTS (Appendix 12)

The experimental data for acute aquatic toxicity that are available, indicate that values >1000 mg/l. The No Observed Effect Loading in the chronic toxicity study show that such materials do not pose a long–term hazard to the environment. However, due to the limited data set available and the potentially variable composition of substances falling within this group, it is not appropriate to draw general conclusions about their chronic aquatic toxicity.

Untreated distillate aromatic extracts do not meet the criteria for ready degradability. Hydrocarbon components of these substances have values for log K_{ow} in the range 4.4 to greater than 6.

Recommended classification: Dangerous for the environment, no symbol, R53 (unless chronic data justify no classification; other classifications may apply based on acute toxicity data).

5.13. TREATED DISTILLATE AROMATIC EXTRACTS (Appendix 13)

Experimental data for acute aquatic toxicity that are available, indicate that values for acute toxicity are >1000 mg/l, whilst the No Observed Effect Loading Rate in a study of chronic toxicity was 1000 mg/l. However, due to the limited data set available and the potentially variable composition of substances falling within this group, it is not appropriate to draw general conclusions on their aquatic toxicity.

Treated distillate aromatic extracts are not expected to meet the criteria for ready degradability. Hydrocarbon components of these substances have values for log K_{ow} in the range 4 to greater than 6.

Recommended classification: Dangerous for the environment, no symbol, R53 (unless chronic data justify no classification; other classifications may apply based on acute toxicity data).

5.14. OTHER AROMATIC EXTRACTS (Appendix 14)

Due to the highly variable nature of substances falling within this group, it is not appropriate to draw general conclusions about their aquatic toxicity. The predicted acute toxicity of substances from this group, based on their hydrocarbon composition, suggest a wide range of possible aquatic toxicity.

Substances in this group would not be expected to meet the criteria for ready degradability. Hydrocarbon components of these substances have values for log K_{ow} in the range 3.3 to greater than 6.

Recommended classification: Dangerous for the environment, no symbol, R53 (unless chronic data justify no classification; other classifications may apply based on acute toxicity data).

5.15. PARAFFIN AND HYDROCARBON WAXES (Appendix 15)

QSAR assessment of the toxicity of the substances in this group, based on their hydrocarbon composition, indicates that they would not be expected to cause acute toxicity to aquatic organisms.

Substances in this group do not meet the criteria for ready degradability. However, based on read across of chronic toxicity results from related high molecular weight hydrocarbons (i.e., lubricants and hydrocarbon solvents), the substances in this group would not be expected to pose a long-term hazard to the environment.

Recommended classification: No classification for environmental effects.

5.16. FOOTS OILS (Appendix 16)

QSAR assessment of the toxicity of the substances in this group, based on their hydrocarbon composition, indicates that they would not be expected to cause acute toxicity to aquatic organisms.

Foots oils are not expected to meet the criteria for ready degradability. Hydrocarbon components of foots oils have values for log K_{ow} greater than 6. However, based on

read across of chronic toxicity results from related high molecular weight hydrocarbons (i.e., lubricants and hydrocarbon solvents), the substances in this group would not be expected to pose a long-term hazard to the environment.

Recommended classification: No classification for environmental effects.

5.17. SLACK WAXES (Appendix 17)

QSAR assessment of the toxicity of the substances in this group, based on their hydrocarbon composition, indicates that they would not be expected to cause acute toxicity to aquatic organisms.

Slack waxes do not meet the criteria for ready degradability. Hydrocarbon components of slack waxes have values for log K_{ow} greater than 6. However, based on read across of chronic toxicity results from related high molecular weight hydrocarbons (i.e., lubricants and hydrocarbon solvents), the substances in this group would not be expected to pose a long-term hazard to the environment.

Recommended classification: No classification for environmental effects.

5.18. PETROLATUMS (Appendix 18)

QSAR assessment of the toxicity of the substances in this group, based on their hydrocarbon composition, indicates that they would not be expected to cause acute toxicity to aquatic organisms.

Petrolatums are not expected to meet the criteria for ready degradability. Hydrocarbon components of petrolatums have values for log K_{ow} greater than 6. However, based on read across of chronic toxicity results from related high molecular weight hydrocarbons (i.e., lubricants and hydrocarbon solvents), the substances in this group would not be expected to pose a long-term hazard to the environment.

Recommended classification: No classification for environmental effects.

5.19. USED OILS (Appendix 19)

Due to the highly variable composition of substances falling within this group, it is not appropriate to draw general conclusions on their environmental fate and effects.

However, from the known properties of the hydrocarbon constituents of the original base oils, it is predicted that the hydrocarbon components of used oils will not be readily biodegradable, but will be inherently biodegradable. The biodegradability of additives used in lubricating oil blends and their degradation products formed during use, has not been investigated.

Recommended classification: Dangerous for the environment, no symbol, R53 (unless chronic data justify no classification; other classifications may apply based on acute toxicity data).

5.20. REREFINED OILS (Appendix 20)

The compositions of substances in this group are dependent on the nature of the feedstocks and the processes to which they have been subjected. Since these processes vary considerably, it is not possible to draw general conclusions on their environmental fate and effects.

In 28-day closed bottle tests conducted to OECD guideline 301D, two samples of hydrotreated spent lubricating oil, CAS No. 64742-58-1 were biodegraded by 6.7% and 9.1%. The results for these samples show that they are clearly not readily biodegradable.

Recommended classification: Dangerous for the environment, no symbol, R53 (unless chronic data justify no classification; other classifications may apply based on acute toxicity data).

5.21. BITUMENS (Appendix 21)

QSAR assessment of the toxicity of the substances in this group, based on their hydrocarbon composition, indicates that they would not be expected to cause acute toxicity to aquatic organisms.

Bitumens are not expected to meet the criteria for ready degradability. Hydrocarbon components of bitumens have values for log K_{ow} greater than 6. However, based on read across of chronic toxicity results from related high molecular weight hydrocarbons (i.e., lubricants and hydrocarbon solvents), the substances in this group would not be expected to pose a long-term hazard to the environment.

Recommended classification: No classification for environmental effects.

5.22. PETROLEUM COKES (Appendix 22)

QSAR assessment of the toxicity of the substances in this group, based on their hydrocarbon composition, indicates that they would not be expected to cause acute toxicity to aquatic organisms.

Petroleum cokes are not expected to meet the criteria for ready degradability. The trace hydrocarbon components of petroleum cokes have values for log K_{ow} greater than 6. However, based on their physico-chemical properties (i.e., negligible solubility), the substances in this group would not be expected to pose a long-term hazard to the environment.

Recommended classification: No classification for environmental effects.

5.23. OTHER PETROLEUM GASES (Appendix 23)

Environmental classification is based on the data for the major components (propane, n-butane and isobutane); these gases have been considered by Environmental Effects Working Group, and it was agreed that they do not meet the criteria for classification as Dangerous for the Environment. Physical properties indicate that petroleum gases will rapidly evaporate from the aquatic environment and that neither acute nor chronic toxic effects will be seen in practice.

Recommended classification: No classification for environmental effects.

5.24. RECLAIM PETROLEUM SUBSTANCES (Appendix 24)

Due to the highly variable composition of substances falling within this group, it is not appropriate to draw general conclusions about their environmental fate and effects.

Recommended classification: Case-by-case basis.

5.25. OTHER PETROLEUM SUBSTANCES (Appendix 25)

Due to the highly variable composition of substances falling within this group, it is not appropriate to draw general conclusions about their environmental fate and effects.

Recommended classification: Case-by-case basis.

6. SUMMARY OF ENVIRONMENTAL CLASSIFICATION RECOMMENDATIONS

The following Table summarises the environmental classification recommendations given in Section 5.

Table 2: Environmental classification and labelling of petroleum substances

Appendix No.	Petroleum substance group	Classification	Symbol	Risk phrase	Safety phrase
1	Crude oil	Dangerous for the environment	-	R52/53	S61
2	Petroleum gases	No classification			
3	Low boiling point naphthas	Dangerous for the environment	N	R51/53*	S61
4	Kerosines	Dangerous for the environment	N	R51/53*	S61
5	Gas oils	Dangerous for the environment	N	R51/53*	S61
6	Heavy fuel oils	Dangerous for the environment	-	R52/53	S61
7	Greases	Dangerous for the environment	-	R53**	S61**
8	Unrefined/acid treated oils	Dangerous for the environment	-	R53**	S61**
9	Highly refined base oils	No classification			
10	Other lubricant base oils	No classification			
11	Residual aromatic extracts	Dangerous for the environment	-	R53**	S61**
12	Untreated distillate aromatic extracts	Dangerous for the environment	-	R53**	S61**
13	Treated distillate aromatic extracts	Dangerous for the environment	-	R53**	S61**
14	Other aromatic extracts	Dangerous for the environment	-	R53**	S61**
15	Paraffin and hydrocarbon waxes	No classification			
16	Foots oils	No classification			
17	Slack waxes	No classification			
18	Petrolatums	No classification			
19	Used oils	Dangerous for the environment	-	R53**	S61**
20	Rerefined oils	Dangerous for the environment	-	R53**	S61**
21	Bitumens	No classification			

Appendix No.	Petroleum substance group	Classification	Symbol	Risk phrase	Safety phrase
22	Petroleum cokes	No classification			
23	Other petroleum gases	No classification			
24	Reclaim petroleum substances	Case-by-case	-	-	-
25	Other petroleum substances	Case-by-case	-	-	-

* Certain hydrocarbon solvents with EINECS numbers included in this group may have compositional and environmental test data supporting a particular classification.

** Applies unless chronic data justify no classification; other classifications may apply based on acute toxicity data.

7. REFERENCES

1. EU (1967) Council Directive of 27 June 1967 on the approximation of laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances (67/548/EEC). Official Journal of the European Communities No. L196, 16.08.1967

2. EU (1993) Commission Directive 93/21/EEC of 27 April 1993 adapting to technical progress for the 18th time Council Directive 67/548/EEC on the approximation of the laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances. Official Journal of European Communities No. L110, 04.05.1993

3. EU (1994) Commission Directive 94/69/EEC of 19 December 1994 adapting to technical progress for the 21st time Council Directive 67/548/EEC on the approximation of laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances. Official Journal of European Communities No. L381, 31.12.1994

4. EU (1996) Commission Directive 96/54/EC of 30 July 1996 adapting to technical progress for the 22nd time Council Directive 67/548/EC on the approximation of the laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances. Official Journal of the European Communities No. L248, 30.09.1996

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8. GLOSSARY OF ABBREVIATIONS

ATP	Adaptation to Technical Progress
BCF	Bioconcentration Factor
BOD_5	Biochemical Oxygen Demand after 5 days
CEC	Coordinating European Council
COD	Chemical Oxygen Demand
DGXI	(former) EC Directorate General 11 (Environment, Nuclear Safety and Civil Protection) (now DG-Environment)
DSD	Dangerous Substances Directive
EC_{50}	Concentration causing 50% effect
EL_{50}	Loading rate causing 50% effect
EC	European Commission
ECB	European Chemicals Bureau
EINECS	European Inventory of Existing Commercial Chemical Substances
EU	European Union
EWG	EU Working Group on Classification and Labelling for Environmental Effects
HSPA	Hydrocarbon Solvent Producers Association
I_rC_{50}	Concentration inhibiting growth rate by 50%
I_rL_{50}	Loading rate inhibiting growth rate by 50%
I_bC_{50}	Concentration inhibiting biomass (area under growth curve) by 50%
I_bL_{50}	Loading rate inhibiting biomass (area under growth curve) by 50%
ISO	International Standards Organisation
K_{ow}	Octanol-water partition coefficient
K_p	Hydrocarbon-water partition coefficient
LC_{50}	Concentration killing 50% of organisms
LL_{50}	Loading rate killing 50% of organisms
NOEL or NOELR	No observed effect loading rate
OECD	Organisation for Economic Cooperation and Development

OWD	Oil-in-Water Dispersion
QSAR	Quantitative Structure Activity Relationship
TGD	Technical Guidance Document (EU risk assessment procedures for substances)
TL_m	Median tolerance limit, the concentration at which 50% of organisms survive
TPC	Technical Progress Committee (of the EC)
TU	Toxic Unit
UK DoE	UK Department of the Environment (now, Department of the Environment, Food and Rural Affairs (DEFRA))
WAF	Water Accommodated Fraction

Risk Phrases

R51/53	Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment
R52/53	Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment
R53	May cause long-term adverse effects in the aquatic environment

Safety Phrases

S29	Do not empty into drains
S35	This material and its container must be disposed of in a safe way
S56	Dispose of this material and its container to hazardous or special waste disposal point
S57	Use appropriate containment to avoid environmental contamination
S59	Refer to manufacturer/supplier for information on recovery/recycling
S60	This material and its container must be disposed of as hazardous waste
S61	Avoid release to the environment. Refer to special instructions/safety data sheet

Symbol N

Pictogram on a product label which indicates that a substance presents an environmental hazard. The symbol is always accompanied by the indication of danger using the words “Dangerous for the Environment”. Substances assigned R50 or R51 carry this symbol, but those assigned R52 do not, although they are classified as Dangerous for the Environment.

APPENDIX 1

CRUDE OIL

1. Description

Crude oil is identified in EINECS as petroleum, CAS No. 8002-05-9. It occurs naturally throughout the world in geological traps. Following recovery, it is freed of gas and associated water before it is pumped though pipelines, or transported by tanker to a refinery for processing .

For labelling purposes, the short name that has been assigned is “crude oil”.

2. Composition/properties

Crude oil is a complex substance varying from a light yellow, mobile, volatile liquid to a viscous black tar according to its origin.

Crude oil consists predominantly of hydrocarbons of the aliphatic, aromatic and naphthenic types and it also contains smaller amounts of organic compounds containing sulphur, nitrogen and oxygen, as well as low concentrations of organo-metallic complexes, in particular of vanadium and nickel. Olefins are rarely found in crude oils.

Crude oils are often characterised in terms of their specific gravities, as measured at 16°C. Light crudes have specific gravities below 0.82, medium crudes have relative densities in the range 0.82 to 0.97 and heavy crudes have relative densities above 0.97.

Little detailed information on the composition of crude oils has been published. The data in the following table have been taken from an IARC publication [1].

***Table 1*:** Typical properties of crude oils

		Crude oil origin	
Property	**Prudhoe Bay**	**South Louisiana**	**Kuwait**
Density (g/ml) at 16°C	0.89	0.85	0.87
Sulphur (% w/w)	0.94	0.25	2.44
Nitrogen (% w/w)	0.23	0.69	0.14
Vanadium (mg/kg)	20	1.9	28
Nickel (mg/kg)	10	2.2	7.7
Alkanes (% w/w)	26.9	28.0	34.1
Naphthenes (% w/w)	35.9	45.4	41.8
Aromatics (% w/w)	28.2	18.6	15.0
Thiophenes (% w/w)	3.0	0.9	9.0

3. Ecotoxicity

3.1 Experimental data

Acute toxicity data for crude oil are summarised in the following table.

Table 2: Acute toxicity data for crude oil

Species	Method	Parameter	Results (mg/l)	References
Fish (various)	OWD	LL_{50}, 96h	3700 – 80000 (6 studies)	[2]
Fish (*Salmo gairdneri*)	OWD	LL_{50}, 96h	258, 291	[3]
Invertebrate (*Crangon crangon*)	OWD	LL_{50}, 96h	27 – 119 (19 studies)	[4]
Invertebrate (*Mysidopsis bahia*)	WAF	LL_{50}, 96h	618	[5]
Invertebrate (*Holmesimysis costata*)	WAF	LL_{50}, 96h	39.5	[5]
Invertebrate (*Palaemonetes pugio*)	OWD	TL_m, 96h	200 - 6000	[2]
Invertebrate (*Mysidopsis almyra*)	OWD	TL_m, 48h	37.5, 63	[2]
Algae (*Anabaena doliolum*)	OWD	I_rL_{50}, 15 day	5.7	[6]

Apart from the algal data included in **Table 2**, no chronic toxicity data relating to crude oil have been identified.

3.2 Predicted Toxicity

As noted the composition of crude oil is quite complex and variable. As a result of the complexity (large number of components), analyses for all components cannot be accomplished. However, a reasonably comprehensive analysis has been published for some crude oils, Prudhoe Bay, Louisiana and Kuwait [1]. For Kuwait crude oil, these data include a composition by carbon number for n-paraffins greater than C_{10} but not for iso-paraffins, nor for paraffins in the naphtha fraction (less than C_{10}). If a uniform distribution by carbon number is assumed for the normal, branched and cyclic paraffins in this naphtha fraction, which constitutes 20% of Kuwait crude, one may use these compositional data to calculate toxicity. The calculated fish LL_{50} of Kuwait crude is 43 mg/l and the calculated *Daphnia* EL_{50} is 17 mg/l. These values are somewhat lower than measured values for crude oil toxicity, but they do not contradict the conclusion that crude oil toxicity is in the range of 10 to 100 mg/l when tested in closed systems to prevent loss of the volatile fraction.

4. Bioaccumulation

No studies have been identified which attempt to measure BCF or log K_{ow} values for crude oils.

Crude oils contain hydrocarbon components which have log K_{ow} values from 2 to over 6. Since most components will have log K_{ow} values above 3, crude oils are considered to have the potential to bioaccumulate.

5. Biodegradation

Five day respirometric tests [7] run both in fresh water and in salt water at 30°C using a Kuwait crude oil resulted in 15% and 3% biodegradation, respectively.

Biodegradation rates for crude oils will vary considerably, but in standard 28-day studies, none would be expected to be readily biodegradable. However, the evidence from spillages and from natural seepages is that most of the non-volatile constituents of crude oil are inherently biodegradable, but that some of the highest molecular weight components are persistent in water.

6. Environmental fate

Most crude oil releases occur in sea water, where wind and wave action contribute significantly to the natural removal processes. Crude oil spreads as a film on the surface of water, facilitating the loss by volatilisation of its lighter components. In air, the volatile hydrocarbons are photodegraded by reaction with hydroxyl radicals [8], their half-lives varying from 0.5 day (e.g. for n-dodecane) to 6.5 days (e.g. for benzene). The water solubility of crude oil is low, only the lower molecular weight aromatic hydrocarbons and some polar compounds showing low, but significant solubilities. The dissolved constituents gradually biodegrade in water. Some of the higher molecular weight compounds are removed by emulsification and these also slowly biodegrade; others adsorb to sediment and sink. A further removal process from the water column, involving the heavier fraction is agglomeration to form tars, some of which are heavier than water and hence, sink.

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APPENDIX 2

PETROLEUM GASES

1. Description

Petroleum gases constitute a group of 91 substances entered in EINECS. They originate from the distillation of crude oil, or as by-products from other refinery operations in particular, those involving cracking processes. All are entered in Annex I of the DSD and for labelling purposes, the short name “petroleum gas” has been assigned. Commercially, the most important members of this group are those identified as liquefied petroleum gas (LPG). The main CAS Nos that are used for LPG are 68476-85-7, 68476-86-8, 92045-80-2 and 68512-91-4. LPG is taken to be representative of petroleum gases in terms of its environmental properties.

2. Composition/properties

LPG consists predominantly of C_3 and C_4 hydrocarbons, the main constituents being propane, n-butane and isobutane [1]. LPG will contain small amounts of hydrocarbons outside these carbon numbers, notably C_5 hydrocarbons. LPG derived from cracking processes will contain olefinic C_3 and C_4 hydrocarbons, notably propene, butenes and butadiene. LPG may also contain sulphur compounds, in particular mercaptans and organic sulphides.

As far as is known, there are no published analytical data for LPG but specifications such as BS4250 [2] include compositional requirements. Recorded physical properties for the hydrocarbon constituents of LPG are given in **Table 1**.

Table 1: Physical properties of the constituents of LPG

Component	Density (g/ml) at 20°C	Boiling point (°C)	Water solubility at 20°C (mg/l)
Propane	0.585 (at -45°C)	-42	65
n-Butane	0.578	-0.5	61
Isobutane	0.549 (at 30°C)	-12	49
Propylene	0.519	-48	200
1-Butene	0.595	-6	222 (at 25°C)
Isobutene	0.604	0.9	263
1,3-Butadiene	0.621	-4.5	731
n-Pentane	0.626	35	39

3. Ecotoxicity

3.1 Experimental data

No aquatic ecotoxicity studies for LPG have been identified, nor for its three principal constituents. The data given in **Table 1** show that on release to water, LPG will readily evaporate from the surface. As such, this substance would not be expected to have any significant ecotoxicological effect on water organisms.

3.2 Predicted toxicity

QSAR calculations enable the prediction of the aquatic toxicities (LC_{50}, EC_{50} and IL_{50} values) for the main constituents of LPG. The calculated aquatic toxicities are as follows:

- for propane, the values for fish, *Daphnia* and algae are in the range 14 to 21 mg/l
- for n-butane and n-pentane, values for these species are in the range 1 to 10 mg/l
- for isobutane, the values for fish, *Daphnia* and algae are 12,8 and 8 mg/l, respectively.

It is apparent from **Table 1** that these gases and their mixtures are soluble at these concentrations and that the calculated toxicities would vary proportionally with the relative amounts of these components. However, the volatility of these hydrocarbons precludes the achievement of these concentrations in the aquatic environment. When the EWG reviewed these data they agreed that the toxicity information available for these hydrocarbons did not meet the criteria for classification as Dangerous for the Environment.

4. Biodegradation

As far as is known, no biodegradation studies have been run on LPG. Zobell [3] reports that 35-day BOD tests were run on methane and ethane at 25°C using adapted micro-organisms and these resulted in 65.7 and 72.6% biodegradabilities, respectively. These results indicate that these gases are inherently biodegradable.

In the real world, the components of petroleum gases do not remain in solution for a sufficient period for biodegradability to be a significant loss process.

5. Bioaccumulation

There are no known determinations of log K_{ow} or BCF values for LPG. Studies for propane, n-butane and isobutane indicate that their log K_{ow} values are 2.3, 2.8 and 2.8, respectively [4]. Since these log K_{ow} values are below 3, LPG is not considered to be potentially bioaccumulative.

6. Environmental fate

Because of their extreme volatility, air is the only environmental compartment in which LPG components will be found. In air, these hydrocarbons are photodegraded by reaction with hydroxyl radicals [5], the quoted half-lives of propane, isobutane and n-butane being 7, 3.4 and 3.2 days, respectively.

7. References

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APPENDIX 3

LOW BOILING POINT NAPHTHAS (GASOLINES)

1. Description

Low boiling point naphthas (LBPNs) are mobile, volatile liquids obtained by a variety of refinery processes using either crude oil or other feedstocks. The processes are reflected in the names given to the refinery streams. In particular, LBPNs are blended to produce the hydrocarbon entity known as gasoline (CAS No. 86290-81-5).

EINECS contains entries for 142 LBPNs. For the purposes of classification under the Dangerous Substances Directive (DSD) and risk assessment under the Existing Substances Regulation, LBPNs have been divided into 7 groups. These groups are identified in **Table 1** which also gives the "short names" associated with the groups; in the 21st ATP of the DSD, each of the Annex I entries for these naphtha streams is identified with a "short name".

Table 1: LBPN groups and short names

Group Name	Short name
Straight-run naphthas	Low boiling point naphtha
Alkylate, isomerate and solvent-extracted naphthas	Low boiling point modified naphtha
Catalytically-cracked naphthas	Low boiling point cat-cracked naphtha
Catalytically-reformed naphthas	Low boiling point cat-reformed naphtha
Thermally cracked naphthas	Low boiling point thermally cracked naphtha
Hydrotreated naphthas	Low boiling point hydrogen treated naphtha
Other naphthas	Low boiling point naphtha - unspecified

2. Composition / Properties

LBPNs consist mainly of hydrocarbons having carbon numbers from C_4 to C_{12}. They contain aliphatic hydrocarbons (normal-, branched-chain and cyclo-alkanes), aromatic hydrocarbons (mainly alkylbenzenes) and olefins.

Typical properties for a number of streams from European refineries are given in **Table 2**.

Table 2: Physico-chemical properties of typical LBPNs

Property/Type	Straight-run	Isomerate	Catalytically Cracked	Reformate	Gasoline blend
CAS No.	64741-46-4	64741-70-4	64741-54-4	68919-37-9	86290-81-5
Boiling range (°C)	88-192	34-149	32-208	40-194	26-195
Density (g/ml at 15°C)	0.759	0.669	0.739	0.801	0.760
Vapour Pressure (kPa at 37.8°C)	12.9	78.6	59.3	46.3	93.0
Alkanes, normal and branched (%, m/m)	45.7	80.3	33.7	30.2	40.3
Cycloalkanes (%, m/m)	33.9	14.4	10.0	2.7	5.7
Alkylbenzenes (%, m/m)	17.3	2.6	18.3	63.8	41.4
Alkylnaphthalenes (%, m/m)	0.0	0.1	0.3	0.1	0.3
Olefins (%, m/m)	2.2	2.6	34.2	1.6	11.6

3. Ecotoxicity

3.1 Experimental data

Valid acute toxicity data for the LBPNs included in **Table 2** using the Water Accommodated Fraction (WAF) method and covering 30 studies are summarised in **Table 3**. These studies have been run in closed systems to prevent loss of hydrocarbons by volatilisation.

Table 3: Acute toxicity data for LBPNs using WAF method in closed vessels

Species	Parameter	Results (mg/l)	References
Fish (*Oncorhynchus mykiss*)	LL_{50}, 96h	10-18 (6 studies)	[1]
Fish (*Pimephales promelas*)	LL_{50}, 96h	8.3	[2]
Fish (*Menidia beryllina*)	LL_{50}, 96h	27	[3]
Invertebrate *(Daphnia magna)*	EL_{50}, 48h	4.5-32 (8 studies)	[1,4]
Invertebrate (*Mysidopsis bahia*)	EL_{50}, 48h	2.0	[5]
Invertebrate (*Mysidopsis bahia*)	EL_{50}, 96h	13.8	[6]
Invertebrate *(Chaetogammarus marinus)*	EL_{50}, 48h	5.9	[5]
Algae (*Selenastum capricornutum*)	I_rL_{50}, 72h	3.1-30,000 (11 studies)	[1]

A number of other studies have been run on gasolines or on marketed gasolines (identified as preparations containing performance additives) using either dispersion methods, or test conditions where the undissolved product remains in contact with the aqueous phase containing the test organisms. These studies have not been conducted in closed systems and hence, significant volatilisation of hydrocarbons has almost certainly occurred, hence, the resulting 50% effect values are higher than those found in closed systems. Accordingly, the resulting test data may not be valid. A summary of the results from these studies is given in **Table 4**.

Table 4: Toxicity data for gasolines using dispersion methods in open systems

Species	Parameter	Results (mg/l)	References
Fish (*Salmo gairdneri*)	LL_{50}, 96h	82,119 (2 studies)	[7]
Fish (*Alosa sapidissima*)	LL_{50}, 48h	91 (1 study)	[8]
Fish (*Alburnus alburnus*)	LL_{50}, 24h	47,58 (2 studies)	[9]
Invertebrate *(Nitocra spinipes)*	EL_{50}, 96h	201 (1 study)	[9]

Other studies have been run on gasolines using the water soluble fraction (WSF) approach, mostly in open systems. Such studies are no longer run and existing data is considered invalid because of the losses by evaporation and because the results cannot be interpreted in terms of EU criteria.

Apart from the algal studies reported in **Table 3** for which NOEL values may be derived, no chronic toxicity studies have been run on LBPNs.

3.2 Predicted Toxicity

The compositions of a variety of representative low boiling point naphthas, ranging from high aromatic reformate to high aliphatic isomerate, have been obtained. The acute aquatic toxicities of these have been calculated by the method described in the main text. These calculations result in calculated toxicities (i.e. LL_{50}, EL_{50} and IL_{50} values) of the substance in the 1 to 10 mg/l range for all compositions comprising the boiling range for low boiling point naphthas. This result is expected from the toxicity/solubility behaviour of the component hydrocarbons.

4. Bioaccumulation

There are no measured BCF or log K_{ow} values for LBPNs. Such studies are not meaningful, since individual components will have different values for these parameters. However, log K_{ow} values have been measured and/or calculated for the hydrocarbon components of LBPNs and for most of these compounds, the values are above 3. Accordingly, LBPNs have to be regarded as being potentially bioaccumulative, although in practice, metabolic processes may prevent this effect.

5. Biodegradability

The ready biodegradability of LBPNs has not been studied. From the known properties of their hydrocarbon components, it is predictable that LBPNs will be inherently biodegradable.

6. Environmental Fate

On release to water, LBPNs will float on the surface and since they are sparingly soluble, the only significant loss process is that of volatilisation. In air, these hydrocarbons are photodegraded by reaction with hydroxyl radicals, the quoted half lives varying from 6.5 days for benzene to 0.5 day for n-dodecane [10].

7. References

1. CONCAWE (1996) Acute aquatic toxicity of gasolines: report on CONCAWE test programme. Report No. 96/57. Brussels: CONCAWE

2. PPSC (1995) Static-renewal 96-hour acute toxicity study of the water accommodated fraction (WAF) of whole light alkylate product to fathead minnow. Study conducted by Stonybrook Laboratories Inc. Study No. 65908. Washington DC: Petroleum Product Stewardship Council

3. PPSC (1995) Static-renewal 96-hour acute toxicity study of the water accommodated fraction (WAF) of whole light alkylate product to silverside minnow. Study conducted by Stonybrook Laboratories Inc. Study No. 65911. Washington DC: Petroleum Product Stewardship Council

4. PPSC (1995) Static-renewal 48-hour acute toxicity study of the water accommodated fraction (WAF) of whole light alkylate product to *Daphnia magna*. Study conducted by Stonybrook Laboratories Inc. Study No. 65907. Washington DC: Petroleum Product Stewardship Council

5. Adema, D.M.M. and van den Bos Bakker, G.H. (1986) Aquatic toxicity of compounds that may be carried by ships (Marpol 1973, Annex II). A progress report for 1986 from TNO to the Dutch Ministry of Housing, Physical Planning and the Environment. Report No. 86/326a. Delft: TNO

6. PPSC (1995) Static-renewal 96-hour acute toxicity study of the water accommodated fraction (WAF) of whole light alkylate product to mysid shrimp. Study conducted by Stonybrook Laboratories Inc. Study No. 65910. Washington DC: Petroleum Product Stewardship Council

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8. Tagatz, M.E. (1961) Reduced oxygen tolerance and toxicity of petroleum products to juvenile American Shad. *Science 2, 65-71*

9. Tarkpea, M. and Svandberg, O. (1982) The acute toxicity of motor fuels to brackish water organisms. *Mar Pollut Bull 13, 4, 125-127*

10. Atkinson, R. (1990) Gas-phase tropospheric chemistry of organic compounds: a review. *Atmos Environ 24A, 1-41*

APPENDIX 4

KEROSINES

1. Description

Kerosines are middle distillate fuels obtained from crude oil by various refining processes. EINECS contains 31 petroleum substances recognised as kerosines and for classification and risk assessment purposes, these have been allocated to three groups [1], as follows:

- straight-run kerosines obtained by the atmospheric distillation of crude oil
- cracked kerosines obtained from refinery feedstocks by thermal, catalytic or steam cracking processes
- other kerosines obtained when straight-run or cracked kerosines are subjected to further refining processes.

For labelling purposes, the short names for kerosines are “straight run kerosine”, “cracked kerosine” and “kerosine - unspecified”, according to the group to which a particular substance has been assigned.

2. Composition/Properties

Kerosines consist mainly of C_9 to C_{16} hydrocarbons and have a boiling range from 145 to 300°C. Normally, they consist of 70-80% aliphatic hydrocarbons, 20-30% aromatic hydrocarbons and contain no more than 5% of olefins [2].

Typical data for one kerosine from each of the three groups are given in **Table 1**.

Table 1: Typical properties of kerosines

	Kerosine Type		
Property	**Straight-run**	**Hydrocracked**	**Hydrodesulphurised**
CAS No.	8008-20-6	10136-80-7	64742-81-0
Aliphatic hydrocarbons (%, m/m)	77.9	79.0	77.2
Aromatic hydrocarbons (%, m/m)	20.2	19.3	21.4
Olefins (%, m/m)	1.9	1.7	1.4
Density at 15°C (g/ml)	0.811	0.808	0.803
Boiling range (°C)	175-261	187-288	156-255
Sulphur (mg/kg)	varies	<20	<20
Reference	[3]	[4]	[5]

3. Ecotoxicity

3.1 Experimental data

Acute toxicity data for kerosines embracing 13 studies are summarised in **Table 2**.

***Table 2*:** Acute toxicity data for kerosines

Species	Method	Parameter	Results (mg/l)	References
Fish (*Oncorhynchus mykiss*)	WAF	LL_{50}, 96h	18-25 (4 studies)	[6,7]
Invertebrate *(Daphnia magna)*	WAF	EL_{50}, 48h	1.4-21 (3 studies)	[6]
Algae (*Raphidocelis subcapitata*)	WAF	I_rL_{50}, 72h	3.7-8.3 (3 studies)	[6]
Invertebrate *(Chaetogammarus marinus)*	WAF (sea water)	EL_{50}, 96h	1	[8]
Fish (*Brachydanio rerio*)	WAF	LL_{50}, 96h	7.3	[9]
Fish (*Pimephales promelas*)	OWD	LL_{50}, 96h	45	[10]

Apart from the algal studies referred to in **Table 2** for which NOEL values may be derived, the only valid chronic toxicity data for kerosines derive from a study by Klein and Jenkins [11] on American flagfish (*Jordenella floridae*) using JP-8, a kerosine-based jet fuel. In this study covering a 128-day period and using a flow through technique, a NOEC (No Observed Effect Concentration) of 1 mg/l was determined for the growth rate of young fish.

3.2 Predicted toxicity

Data are available on the chemical composition of representative kerosines [3,4,5] in which the n-paraffins were quantified by individual carbon number. The difficulty of large numbers of isomers results in a lack of chromatographic resolution (unresolvable complex mixture) for the branched and cycloparaffins within the kerosine boiling range. For purposes of the calculation, the local branched and cyclic hydrocarbons were assumed to be distributed by boiling points in the same proportion as the n-paraffins. The calculated toxicities based on these compositions were in the 1 to 10 mg/l range for fish and 0.4 to 4 mg/l for *Daphnia*. The calculated toxicity was primarily due to the assumed content of cycloparaffin components in the C_9 and C_{10} range and, secondarily, to the alkylbenzenes in the same carbon number range. These components are those boiling within the range of 145-300°C. The calculated toxicity has uncertainty associated with both the exact components of cycloparaffins and alkylbenzenes in kerosines and the extrapolation for substances having *Daphnia* QSAR values up to log K_{ow} of 6. Given this uncertainty, the measured toxicities are more reliable than those obtained by calculation and should take precedence.

4. Bioaccumulation

Klein and Jenkins [11] measured BCF values for jet fuel JP-8 using American flagfish (*Jordenella floridae*) and rainbow trout (*Salmo gairdneri*) in flow through studies with exposure periods of 128 and 112 days, respectively. The observed BCF values were in the range 130-159 for flagfish and 61-115 for rainbow trout.

Log K_{ow} values for the hydrocarbon components of kerosines are in the range 3.3 to 6 and above and these data indicate that kerosines have the potential to bioaccumulate, although in practice, metabolic processes may reduce the bioconcentration observed. This conclusion is supported by the noted differences in the theoretical and measured BCF values.

5. Biodegradation

There are no known data for the ready biodegradability of kerosine refinery streams using OECD procedures. However, from the known properties of hydrocarbons in the range C_9 to C_{16}, it is considered that kerosines are not readily biodegradable, but as they can be degraded by micro-organisms, they are regarded as being inherently biodegradable [12].

6. Environmental fate

The aquatic toxicity data given in section 3 have mainly been generated in closed systems so that the intrinsic toxicities of the kerosines were defined. In the real world situation, releases of kerosines to water will result in a film of hydrocarbons floating on the surface. Since the water solubility of the hydrocarbons is extremely low, the predominant loss process from water is volatilisation, although it is possible that some of the higher molecular weight hydrocarbons will be adsorbed on sediment. Biodegradation in water is a minor loss process. In air, the hydrocarbon constituents of kerosines react readily with hydroxyl radicals and their half lives in the atmosphere are mostly in the range of 0.1 to 0.7 days [13].

7. References

1. CONCAWE (1995) The classification and labelling of dangerous substances according to the EU dangerous substances directive. Report No. 95/59. Brussels: CONCAWE

2. CONCAWE (1995) Kerosines/jet fuels. Product Dossier No. 94/106. Brussels: CONCAWE

3. API (1987) Comprehensive analytical analysis of API generic refinery streams. Washington DC: American Petroleum Institute

4. CONCAWE (1995) Physical-chemical characterisation: study number 188490: test substance MRD-94-884. Study conducted by Exxon Biomedical Sciences Inc. Brussels: CONCAWE

5. CONCAWE (1995) Physical-chemical characterisation: study number 188590: test substance MRD-94-885. Study conducted by Exxon Biomedical Sciences Inc. Brussels: CONCAWE

6. CONCAWE (1996) Acute aquatic toxicity of kerosines: report on CONCAWE test programme. Report No. 96/55. Brussels: CONCAWE

7. DSM Kunststoffen BV (1989) The acute toxicity of C_9 resinfeed to *Brachydanio rerio*. Study conducted by TNO. Report No. R89/225. Beek: DSM

8. DSM Kunststoffen BV (1987) The acute toxicity of CR to the crustacean *Chaetogammarus marinus*. Study conducted by TNO. Report No. R87/378. Sittard: DSM

9. DSM Kunststoffen BV (1989) The acute toxicity of cracked distillate to *Brachydanio rerio*. Study conducted by TNO. Report No. R89/224. Beek: DSM

10. Hedtke, S.F. and Puglisi, F.A. (1982) Short-term toxicity of five oils to four freshwater species. *Arch Environ Contam Toxicol 11, 425-430*

11. Klein, S.A. and Jenkins, D. (1983) The toxicity of jet fuels to fish – II. The toxicity of JP-8 to flagfish (*Jordanella floridae*) and rainbow trout (*Salmo gairdneri*) and golden shiners (*Notemigonus chysoleucas*). *Water Research 17, 10, 1213-1220*

12. Atlas, R.M. (1984) Petroleum microbiology. New York: Macmillan Publishing Co.

13. Atkinson, R. (1990) Gas-phase tropospheric chemistry of organic compounds: a review. *Atmos Environ 24A, 1-41*

APPENDIX 5

GAS OILS

1. Description

Gas oils are middle distillate fuels obtained from crude oil by various refining processes. EINECS contains entries for 69 gas oils and for classification and risk assessment purposes [1], they have been allocated to six groups as follows:

- straight-run gas oils obtained by the atmospheric distillation of crude oil. (straight-run gas oil)
- cracked gas oils obtained from refinery feedstocks by thermal, catalytic or steam cracking processes. (cracked gas oil)
- hydrocracked gas oils obtained from refinery feedstocks by simultaneous processes of cracking and hydrogenation. (cracked gas oil)
- gas oil distillate fuels normally obtained by blending straight-run, cracked and hydrocracked gas oils. (gas oil - unspecified)
- Distillates obtained by vacuum distillation of the residues left after the atmospheric distillation of crude oil. (vacuum gas oil)
- Other gas oils obtained when straight-run or cracked gas oils are subjected to further refining processes. (gas oil - unspecified)

The short names used for labelling purposes are included in parentheses.

2. Composition/Properties

Gas oils consist mainly of C_9 to C_{30} hydrocarbons and have a boiling range from 145 to 450°C. Straight-run and vacuum gas oils typically contain 70-80% aliphatic hydrocarbons, 20-30% aromatic hydrocarbons and less than 5% of olefins. However, cracked gas oils may contain up to 75% of aromatic hydrocarbons and up to 10% olefins [2]. Since part of the gas oils distil at temperatures in excess of 350°C, they may contain minor concentrations of 4 to 6 ring polycyclic aromatic hydrocarbons.

Typical data for four gas oils, each of a different type are given in **Table 1**.

Table 1: Typical properties of gas oils

Property	Straight-run	Catalytic cracked	Hydrocracked	Diesel Fuel
CAS No	64741-44-2	64741-59-9	64741-77-1	68334-30-5
Aliphatic hydrocarbons (%, m/m)	79.7	24.0	47.9	71.9
Aromatic hydrocarbons (%, m/m)	20.3	72.4	21.0	28.1
Olefins (% $^{w}/_{w}$)	<0.1	3.7	4.4	1.0
Density at 15°C (g/ml)	0.844	0.972	0.837	0.834
Boiling range (°C)	185-391	240-372	216-347	143-347
Sample No.	API 83-11	API 83-07	DGMK No. 11	DGMK No. 24
Reference	[3]	[3]	[4]	[4]

3. Ecotoxicity

3.1 Experimental data

Acute toxicity data are available for the following gas oils:

diesel fuel (CAS No. 68334-30-5)

steam cracked gas oil (CAS No. 68527-18-4)

fuel oil No. 2 (CAS No. 68476-30-2)

A total of 28 studies were identified and the results are summarised in **Table 2**.

Table 2: Acute toxicity data for gas oils

Species	Method	Parameter	Results (mg/l)	References
Fish (*Oncorhynchus mykiss*)	WAF	LL_{50}, 96h	21-230 (4 studies)	[5,6,7,8]
Fish (*Jordanella floridae* and *Pimephales promelas*)	OWD	LL_{50}, 96h	31,54 (2 studies)	[9]
Fish (*Cyprinodon variegatus, Menidia beryllina* and *Fundulis similis*)	OWD	TL_m, 96h	33-125 (3 studies)	[10]
Invertebrate *(Daphnia magna)*	WAF	EL_{50}, 48h	6.2-210 (12 studies)	[5,6,7,8,11]
Invertebrate *(Mysidopsis almyra)*	OWD	TL_m, 48h	1.6	[10]
Invertebrate *(Palaemonetes pugio)*	OWD	TL_m, 48h	3.4	10
Invertebrate (*Penaeus aztecus*)	OWD	TL_m, 48h	9.4	[10]
Algae (*Raphidocelis subcapitata*)	WAF	I_rL_{50}, 72h	>10-78 (4 studies)	[5,6,7,8]

Apart from the algal studies referred to in **Table 2** from which NOEL values may be derived, there are no known chronic aquatic toxicity data for gas oils.

3.2 Predicted toxicity

Detailed hydrocarbon analyses are not available for gas oils, but the boiling range and general composition of hydrocarbons are very similar to kerosines, with the exception that the upper limit of the boiling range is 450°C [3,4]. Hydrocarbons boiling in the 300-450°C range are too insoluble to contribute to aquatic toxicity. However, although the heavy gas oils contain no hydrocarbons which would be expected to have sufficient water solubility to cause acute aquatic toxicity, they may contain non-hydrocarbon polar components which would be more water soluble and could possibly cause acute toxicity. It is expected that the calculated toxicities for light or wide range gas oils may be similar those for kerosines. The measured toxicity data should take precedence over calculated toxicity data for these substances.

4. Bioaccumulation

Stainken [12] attempted to measure the BCF values of components of No. 2 fuel oil (a gas oil based grade) exposed as an emulsion to clams (*Mya arenaria*). The highest recorded BCF value was only 8.5. Similarly, Werner and Kimerle [13] found a measured BCF value for n-dodecylbenzene ($C_{18}H_{30}$) of only 25. However, log K_{ow} values for the hydrocarbon components of gas oils range from 3.9 to greater than 6 indicating a potential to bioaccumulate, but in practice, metabolic processes may reduce the bioconcentration observed.

5. Biodegradation

Few data are available on the ready biodegradability of gas oils using the standard 28-day OECD biodegradability test procedures. Battersby et al [14] observed 40% biodegradation for a gas oil in a 28-day test using the modified Sturm procedure. To illustrate the differing properties of hydrocarbon solvents, a ready biodegradability study [15] was run on such a solvent identified as an acid treated, middle distillate (CAS No. 64742-13-8) using OECD procedure 301F, a respirometric method. In this study, 61% biodegradation was observed over the 28 day period, indicating that this solvent was readily biodegradable. However, since hydrocarbon solvents have narrower ranges of compositions than their corresponding refinery streams, no inference regarding the latter can be drawn from this result. Overall, gas oils are regarded as being inherently biodegradable, since their hydrocarbon components can be degraded by micro-organisms.

6. Environmental fate

Releases of gas oils to water will result in films of hydrocarbons floating and spreading on the surface. For the lighter components, volatilisation is an important loss process and since these are the more ecotoxic, the hazard to aquatic organisms is reduced. In air, the hydrocarbon vapours react readily with hydroxyl radicals, their half lives being less than a day [16]. Photoxidation of liquid hydrocarbons on the water surface is also a significant loss process particularly for polycyclic aromatic compounds. In water, the majority of gas oil components will be adsorbed on sediment. On release to soil, gas oils show some mobility, but adsorption is the predominant physical process. Adsorbed hydrocarbons from gas oils will slowly degrade, both in water and soil.

7. References

1. CONCAWE (1995) The classification and labelling of dangerous substances according to the EU dangerous substances directive. Report No. 95/59. Brussels: CONCAWE

2. CONCAWE (1996) Gas oils (diesel fuels/heating oils). Product dossier No. 95/107. Brussels: CONCAWE

3. API (1987) Comprehensive analytical analysis of API generic refinery streams. Washington DC: American Petroleum Institute

4. Deininger, G. et al (1991) Middle distillates: analytical investigations and mutagenicity studies. DGMK Project 412-1. Hamburg: DGMK

5. Shell Research Ltd. (1996) Gasoil sample 1: acute toxicity of water accommodated fractions to *Oncorhynchus mykiss*, *Daphnia magna* and *Raphidocelis subcapitata*. Report No. OT.96.40017. Thornton: Shell Research and Technology Centre

6. Shell Research Ltd. (1996) Gasoil sample 2: acute toxicity of water accommodated fractions to *Oncorhynchus mykiss*, *Daphnia magna* and *Raphidocelis subcapitata*. Report No. OT.96.40018. Thornton: Shell Research and Technology Centre

7. Shell Research Ltd. (1996) Gasoil sample 3: acute toxicity of water accommodated fractions to *Oncorhynchus mykiss*, *Daphnia magna* and *Raphidocelis subcapitata*. Report No. OT.96.40060. Thornton: Shell Research and Technology Centre

8. Shell Research Ltd. (1996) Gasoil sample 4: acute toxicity of water accommodated fractions to *Oncorhynchus mykiss*, *Daphnia magna* and *Raphidocelis subcapitata*. Report No. OT.96.40123. Thornton: Shell Research and Technology Centre

9. Hedtke, S.F. and Puglisi, F.A. (1982) Short-term toxicity of five oils to four freshwater species. *Arch Environ Contam Toxicol 11, 425-430*

10. Anderson, J.W. et al (1974) Characteristics of dispersions and water-soluble extracts of crude and refined oils and their toxicity to estuarine crustaceans and fish. *Mar Biol 27, 75-88*

11. Fraunhofer (2000) *Daphnia magna*, acute immobilization test with gas oil WAFs. Schmallenberg: Fraunhofer Institut Umweltchemie und Ökotoxikologie (draft report)

12. Stainken, D. (1977) The accumulation and depuration of No. 2 fuel oil by the soft shell clam, *Mya arenaria*. In: Wolfe, D.A. (Ed). Fate and effects of petroleum hydrocarbons in marine ecosystems and organisms. New York: Pergamon Press

13. Werner, A.F. and Kimerle, R.A. (1982) Uptake and distribution of C_{12} alkylbenzene in bluegill (*Lepomis macrochirus*). *Environ Toxicol Chem 1, 143-146*

14. Battersby, N.S. et al (1992) A correlation between the biodegradability of oil products in the CEC L-33-T-82 and modified Sturm tests. *Chemosphere 24, 12, 1989-2000*

15. CEFIC (1995) Ready biodegradability of PKWF 4/7. Study conducted by Exxon Biomedical Sciences Inc. Project No. 186694A. Brussels: Conseil Européen des Fédérations de l'Industrie Chimique

16. Atkinson, R. (1990) Gas-phase tropospheric chemistry of organic compounds: a review. *Atmos Environ 24A, 1-41*

APPENDIX 6

HEAVY FUEL OIL COMPONENTS

1. Description

Heavy fuel oils are primarily residues from crude oil distillation and cracking processes. In practice, these refinery products are blended to a range of viscosities to make them suitable for particular applications. EINECS includes entries for 41 heavy fuel oil streams, which for classification and risk assessment purposes [1] have been grouped together. For labelling purposes, the short name “heavy fuel oil” has been assigned to these substances.

2. Composition / Properties

Heavy fuel oil streams contain saturated, aromatic and olefinic hydrocarbons, mainly in the carbon number range C_9 to C_{50}. The boiling ranges of these streams are approximately 160 to 600^{o}C, and hence they may contain 4 to 6 ring polycyclic aromatic hydrocarbons. In addition, as they include residual streams, they may also contain low concentrations of heavy metals such as vanadium and nickel.

3. Ecotoxicity

3.1 Experimental data

Seven valid acute toxicity studies have been identified for heavy fuel oils and these are summarised in **Table 1**.

Table 1: Acute toxicity data for heavy fuel oils

Species	Method	Parameter	Results (mg/l)	Reference
Fish (*Oncorhynchus mykiss*)	WAF	LL50, 96h	>1000	[2]
Fish (*Oncorhynchus mykiss*)	WAF	LL50, 96h	>100 - 1000	[3]
Fish (*Brachydanio rerio*)	WAF	LL50, 96h	48	[4]
Invertebrate (*Daphnia magna*)	WAF	EL50, 48h	>1000	[2]
Invertebrate (*Daphnia magna*)	WAF	EL50, 48h	220 - 460	[3]
Algae (*Raphidocelis subcapitata*)	WAF	I_rL50, 72h	100 - 300	[2]
Algae (*Raphidocelis subcapitata*)	WAF	I_rL50, 72h	30 - 100	[3]

With the exception of the algal studies referred to in **Table 1** from which NOEL values may be derived, there are no known chronic aquatic toxicity data for heavy fuel oils.

3.2 Predicted toxicity

The composition of heavy fuel oils is complex and variable. As a consequence of this complexity, complete analyses of components are not available. However on the basis of the carbon number range and typical hydrocarbon structures present, acute aquatic toxicity primarily in the range observed i.e. 10 to 100 mg/l, would be predicted.

4. Bioaccumulation

No studies were identified which attempt to measure BCF or log K_{ow} values for heavy fuel oils. However, the hydrocarbon components of heavy fuel oils have log K_{ow} values ranging from 2.7 to greater than 6, indicating a potential to bioaccumulate, but in practice, metabolic processes may reduce the bioconcentration observed.

5. Biodegradation

As far as is known to CONCAWE, no data are available on the ready biodegradability of heavy fuel oils using the standard OECD test procedures. There is, however, evidence of slow biodegradation of fuel oil under anaerobic conditions (11% after 28 days) [5]. In general, heavy fuel oil components are regarded as inherently biodegradable, but not readily biodegradable in water.

6. Environmental Fate

Releases of heavy fuel oils to water will generally result in films of hydrocarbons floating and slowly spreading on the surface, although some samples may have densities greater than that of fresh water. Dissolution of hydrocarbon components in water will be limited, but losses through sediment adsorption will be significant. For the lighter components, volatilisation is an important loss process and since these are more toxic to aquatic organisms, then the hazard to species in the water is correspondingly reduced. In air, hydrocarbon vapours react readily with hydroxyl radicals, their half-lives being less than a day [6].

7. References

1. CONCAWE (1995) The classification and labelling of dangerous substances according to the EU dangerous substances directive. Report No. 95/59. Brussels: CONCAWE

2. Shell Research Ltd. (1997) Light fuel oil: acute toxicity of water accommodated fractions to *Oncorhynchus mykiss*, *Daphnia magna* and *Raphidocelis subcapitata*. Study conducted by Sittingbourne Research Centre. Report No. OP.97.47001. Thornton: Shell Research and Technology Centre

3. Shell Research Ltd. (1997) Heavy fuel oil: acute toxicity of water accommodated fractions to *Oncorhynchus mykiss*, *Daphnia magna* and *Raphidocelis subcapitata*. Study conducted by Sittingbourne Research Centre. Report No. OP.97.47002. Thornton: Shell Research and Technology Centre

4. DSM Kunststoffen BV (1989) The acute toxicity of carbon black oil to *Brachydanio rerio*. Study conducted by TNO. Report No. R89/226. Beek: DSM

5. Walker, J.D. et al (1976) Comparison of the biodegradability of crude and fuel oils. *Can J Microbiol 22, 4, 598-602*

6. Atkinson, R. (1990) Gas-phase tropospheric chemistry of organic compounds: a review. *Atmos Environ 24A, 1-41*

APPENDIX 7

LUBRICATING GREASES

1. Description

Lubricating greases are very viscous products, normally consisting of base oils and thickening agents. There is a single entry for lubricating greases in EINECS (CAS No. 74689-21-9). For labelling purposes, the agreed short name for this substance is “grease”.

2. Composition / Properties

The base oil constituents of greases will normally be one of the substances referred to in **Appendix 10** as “other lubricant base oils”. Such base oils consist of complex combinations of hydrocarbons extending over the carbon number range from C_{12} to C_{50}.

The thickening agents are identified as organic salts of alkali or alkaline earth metals, or aluminium compounds. Typical thickeners are aluminium silicate and compounds of sodium, calcium and lithium. Further additives may be blended with lubricating greases to convey particular properties, but the resulting products are preparations.

Due to the diverse nature of greases it is not possible to list typical properties. Specifications for greases particularly relate to their physical properties (e.g. penetration value, drop point etc.). Greases have negligible vapour pressure at ambient temperatures. The base oil constituents of greases are very sparingly soluble in water, but some of the thickeners have more significant water solubilities and may confer a slight alkalinity to the water.

3. Ecotoxicity

3.1 Experimental data

A single acute toxicity study in fish is available [1]. In this study, rainbow trout were exposed to a dispersion of a lithium grease in water. The 96h LL_{50} was found to be >2,000 mg/l.

3.2 Predicted toxicity

The base oil constituents of greases would not be expected to cause acute or chronic toxicity to aquatic organisms based on the data given in **Appendix 10**. However, the metal salts used as thickeners may have associated water solubility and could conceivably have aquatic effects. The model used to evaluate the distribution of components between oil and water is not applicable to inorganic salts. Moreover, due to the variety of thickeners used, it is not feasible to generalise the potential aquatic toxicity of the greases.

4. Bioaccumulation

No studies were identified that attempt to measure the BCF or log K_{ow} values of greases. Further, such studies would not be meaningful, since each individual component of this complex substance will have its own values for these parameters.

From the carbon number range of the base oil constituents, it may be deduced that the log K_{ow} range of these substances will extend from 4 to over 6. Accordingly, lubricating

greases must be assumed to have the potential to bioaccumulate, although in practice, metabolic processes may reduce the bioconcentration observed.

5. Biodegradability

There are no known studies on the biodegradability of greases. The base oil constituents of greases are expected to be inherently, but not readily biodegradable, based on the biodegradability of their constituent hydrocarbons. Some of the thickening agents may be readily biodegradable. The concept of biodegradability does not apply to metallic cations such as sodium or lithium.

6. Environmental Fate

Due to the complex nature of the greases, little may be said about their environmental fate. Their low vapour pressures indicate that volatilisation to air would not be a very significant fate process. The components may behave differently in the aquatic environment with soaps dispersing and dissolving to some extent in water while the hydrocarbon portion will be of very low solubility and would float to the surface. The hydrocarbon portion would be expected to show low mobility in soil and water. The major environmental fate of the organic portion of greases would be expected to be biodegradation.

7. References

1. BenKinney, M.T. et al (1991) A new method for evaluating the aquatic toxicity of greases. Proceedings of Society of environmental toxicology and chemistry (SETAC) conference on environmental interfaces, scientific and socio-economic, Seattle WA

APPENDIX 8

UNREFINED / ACID TREATED OILS

1. Description

There are 12 entries in EINECS for the group of lubricant base oils identified as unrefined and acid treated base oils. Unrefined oils are straight run vacuum distillates obtained by vacuum distillation of the residue obtained after the atmospheric distillation of crude oil. Acid treated base oils are vacuum distillates that have been further treated with sulphuric acid to remove some of the aromatic hydrocarbons.

For labelling purposes, these base oils have been assigned the short name “unrefined or mildly refined base oil”.

2. Composition / Properties

Unrefined and acid treated base oils consist principally of hydrocarbons covering the carbon number range C_{15} to C_{50} [1]. They consist of the following generic types of hydrocarbon:

- straight and branched chain alkanes
- naphthenes i.e. mono, di-, tri-, tetra- etc, cycloalkanes
- aromatic hydrocarbons including alkylbenzenes and 2 to 7 fused ring compounds.

Nitrogen and sulphur containing compounds including some heterocyclics may be present in small amounts in unrefined base oils. Olefins are rarely found in this group of base oils.

Base oils in this group are often described as either paraffinic or naphthenic depending on whether alkanes or naphthenes are the predominant generic type of hydrocarbons present.

Base oils are also described as light or heavy depending on their viscosities. In general:

- Light base oils have viscosities below 19 mm^2/s at 40°C and mostly contain hydrocarbons in the carbon number range C_{15} to C_{30}.
- Heavy base oils have viscosities above 19 mm^2/s at 40°C and mostly contain hydrocarbons in the carbon number range C_{20} to C_{50}.

These base oils have negligible vapour pressures at ambient temperatures and have very low water solubilities.

3. Ecotoxicity

3.1 Experimental data

No ecotoxicity studies are known for unrefined and acid treated base oils.

3.2 Predicted Toxicity

It is predicted from the work of Adema [2] and from comparison of toxicity QSARs [3] with solubility behaviour that both paraffinic and naphthenic hydrocarbons in the range of C_{15} to C_{50} are too water insoluble to cause acute aquatic toxicity. However, without detailed compositional and chemical information, it is not possible to predict the water solubility and toxicity behaviour of the more polar components of unrefined base oils.

4. Bioaccumulation

No studies were identified which attempt to measure the BCF or log K_{ow} values of unrefined or acid treated base oils. Further, such studies would not be meaningful, since each individual component of these complex substances will have its own values for these parameters.

From the carbon number range of the hydrocarbon constituents, it may be deduced that the log K_{ow} range of these substances will extend from 4.5 to over 6. Accordingly, unrefined and acid treated base oils have the potential to bioaccumulate.

5. Biodegradability

There are no known biodegradability studies for unrefined and acid treated base oils.

The hydrocarbon components of these base oils are expected to be inherently biodegradable as micro-organisms capable of utilising such hydrocarbons are widespread in nature [4]. Due to the poor water solubility of these substances, unrefined base oils are not expected to meet the criteria for ready biodegradability. This lack of ready biodegradability of unrefined and acid treated base oils may also be inferred by comparison with other base oils.

6. Environmental Fate

The low vapour pressures of these base oils indicate that volatilisation will not be a very significant fate process. In water, base oils will float and spread over the surface at a rate dependent upon viscosity. In soil and sediment, base oil components will show low mobility with adsorption the predominant physical process. The main fate process is expected to be slow biodegradation of base oil components in soil and sediment.

7. References

1. CONCAWE (1997) Lubricating oil basestocks. Product Dossier No. 97/108. Brussels: CONCAWE

2. Adema, D.M.M. and van den Bos Bakker, G.H. (1986) Aquatic toxicity of compounds that may be carried by ships (Marpol 1973, Annex II). Progress report for 1986 from TNO to the Dutch Ministry of Housing, Physical Planning and Environment. Report No. R 86/326a. Delft: TNO

3. EU (1996) Technical guidance document in support of Commission Directive 93/67/EEC on risk assessment for new notified substances and Commission Regulation (EC) 1488/94 on risk assessment for existing substances. Part IV, Chapter 4: Use of quantitative structure activity relationships (QSARs) in risk assessment. Luxembourg: Office for Official Publications of the European Communities

4. Atlas, R.M. (1984) Petroleum microbiology. New York: Macmillan Publishing Co.

APPENDIX 9

HIGHLY REFINED BASE OILS

1. Description

This group of five EINECS substances comprises two white oils and three brightstock base oils. The white oils are produced from other base oils by two processes, either severe hydrogenation or treatment with oleum. The brightstock base oils are produced from treated residual oils by hydrogenation.

For labelling purposes, the recommended short name is “highly refined base oil”.

2. Composition / Properties

Highly refined base oils are mainly composed of hydrocarbons having carbon numbers in the range C_{15} to C_{50} and over. White oils are composed almost entirely of alkanes (straight and branched chain) and naphthenes (mono-, di-, tri-, tetra- etc cycloalkanes); the aromatic hydrocarbon content of white oils is negligible. Brightstock oils are heavy oils containing hydrocarbons of C_{25} and above. They also consist primarily of alkanes and naphthenes, but additionally, they contain small concentrations of aromatic hydrocarbons [1].

3. Ecotoxicity

3.1 Experimental data

Only one study is known for highly refined base oils. This study [2] in fish (*Lepomis macrochirus*) for an oil in water dispersion of white mineral oil (CAS No. 8042-47-5) which showed no toxicity at the highest loading rate, indicating a 96h, LL_{50} exceeding 10,000 mg/l. (Although conducted in open systems, the lack of volatility of base oils makes this oil in water dispersion study generally valid for fish, where physical entrapment of the test organisms within the oil phase does not occur.)

3.2 Predicted Toxicity

It is predicted from the work of Adema [3] and from comparison of toxicity QSARs [4] with solubility behaviour that both paraffinic and naphthenic hydrocarbons in the range of C_{15} to C_{50} are too water insoluble to cause acute aquatic toxicity. Thus, the highly refined base oils are not expected to show acute aquatic toxicity. This prediction is also substantiated by analogy with the other base oils, which show no acute or chronic aquatic toxicity. Highly refined base oils have lower aromatic content than other base oils and would be expected to be less likely to have water components with sufficient solubility to cause toxicity.

4. Bioaccumulation

No studies were identified which attempt to measure the BCF or log K_{ow} values of highly refined base oils. Further, such studies would not be meaningful, since each individual component of these complex substances will have its own values for these parameters.

From the carbon number range of the hydrocarbon constituents, it may be deduced that the log K_{ow} range of these substances will extend from 4 to over 6. Accordingly, highly

refined base oils are presumed to have the potential to bioaccumulate, although in practice, metabolic processes may reduce the bioconcentration observed.

5. Biodegradability

There are two biodegradation studies available for highly refined base oils. Both studies [5] are on white mineral oil, CAS No. 8042-47-5. This substance showed biodegradabilities of 10% and 24% in OECD 301B (Sturm) and OECD 301D (Closed Bottle) tests, respectively. This same substance exhibited a loss of 49% in the CEC-L-33-A-93 test of primary biodegradability over 21 days [5].

The paraffinic and naphthenic hydrocarbon components of these base oils are expected to be inherently biodegradable as micro-organisms capable of utilising such hydrocarbons are widespread in nature [6]. Due to the poor water solubility of these substances, highly refined base oils are not expected to meet the criteria for ready biodegradability.

6. Environmental Fate

The low vapour pressures of these base oils indicate that volatilisation will not be a very significant fate process. In water, base oils will float and spread over the surface at a rate dependent upon viscosity. In soil and sediment, base oil components will show low mobility with adsorption being the predominant physical process. The main fate process is expected to be slow biodegradation of base oil components in soil and sediment.

7. References

1. CONCAWE (1997) Lubricating oil basestocks. Product Dossier No. 97/108. Brussels: CONCAWE

2. Mobil (1984-1991) In-house company data. Princeton NJ: Mobil Oil Corporation

3. Adema, D.M.M. and van den Bos Bakker, G.H. (1986) Aquatic toxicity of compounds that may be carried by ships (Marpol 1973, Annex II). Progress report for 1986 from TNO to the Dutch Ministry of Housing, Physical Planning and Environment. Report No. R 86/326a. Delft: TNO

4. EU (1996) Technical guidance document in support of Commission Directive 93/67/EEC on risk assessment for new notified substances and Commission Regulation (EC) 1488/94 on risk assessment for existing substances. Part IV, Chapter 4: Use of quantitative structure activity relationships (QSARs) in risk assessment. Luxembourg: Office for Official Publications of the European Communities

5. Battersby, N.S. et al (1992) A correlation between the biodegradability of oil products in the CEC L-33-T-82 and modified Sturm tests. *Chemosphere 24, 12, 1989-2000*

6. Atlas, R.M. (1984) Petroleum microbiology. New York: Macmillan Publishing Co.

APPENDIX 10

OTHER LUBRICANT BASE OILS

1. Description

This is a group of 78 base oils obtained by the further processing of either vacuum distillates or residual oils. The main treatment processes are solvent extraction and catalytic hydrogenation. Clay treatments may also be used to remove polar compounds. The severity of the treatment process determines the extent to which polycyclic aromatic compounds are present in these base oils.

For labelling purposes, substances in this group have been assigned the short name, “base oil – unspecified”.

2. Composition / Properties

These lubricant base oils are mainly composed of hydrocarbons having carbon numbers in the range C_{15} to C_{50}. The principal hydrocarbon types found in these base oils are alkanes (straight and branched chain) and naphthenes (mono-, di-, tri-, tetra- etc cycloalkanes). They also contain varying concentrations of aromatic hydrocarbons i.e. alkylbenzenes and 2 to 7 fused ring aromatics, depending on the severity of the refining process [1].

Base oils in this group are often described as paraffinic or naphthenic depending on whether alkanes or naphthenes are the predominant generic type of hydrocarbons present.

Base oils are also described as light or heavy depending on their viscosities. In general:

- Light base oils have viscosities below 19 mm^2/s at 40°C and mostly contain hydrocarbons in the carbon number range C_{15} to C_{30}.
- Heavy base oils have viscosities above 19 mm^2/s at 40°C and mostly contain hydrocarbons in the carbon number range C_{20} to C_{50}.

Base oils in this group have negligible vapour pressures at ambient temperatures and have very low water solubilities.

3. Ecotoxicity

3.1 Experimental data

There are 14 valid acute toxicity studies for 12 base oils in this group. These data are summarised in **Table 1**. These studies were conducted using either, oil continuously dispersed in water, or oil equilibrated with water and then testing the water accommodated fraction (WAF). For both types of study, no acute toxicities were seen at the highest addition of the various base oils tested.

Table 1: Acute aquatic toxicity data for other base oils

Species	Method	Parameter	Results (mg/l)	References
Fish (*Oncorhynchus mykiss*)	OWD	$LL_{50,}$ 96h	>1000 (10 studies)	[2,3]
Algae (*Scenedesmus subspicatus*)	WAF	I_rL_{50}, 96h	>1000 (4 studies)	[4-7]

In addition to the algal studies referred to in **Table 1** for which NOEL values may be derived, there are 15 valid chronic toxicity studies for base oils in this group. These data are summarised in **Table 2**. These studies were conducted using either, oil continuously dispersed in water, or oil equilibrated with water and then testing the water accommodated fraction (WAF). None of the 15 studies show chronic toxicity at less than 1 mg/l. For all but one study, no chronic toxicities were seen at the highest addition of the various base oils tested.

Table 2: Chronic toxicity data for other base oils

Species	Method	Parameter	NOEL (mg/l)	References
Fish (*Pimephales promelas*)	OWD	Reproduction/ survival	1000-5000 (3 studies)	[2]
Invertebrate *(Ceriodaphnia dubia)*	WAF	Reproduction/ survival	550-5000 (5 studies)	[2]
Invertebrate *(Daphnia magna)*	WAF	Reproduction/ survival	1-1000 (7 studies)	[2,4-11]

3.2 Predicted Toxicity

It is predicted from the work of Adema [12] and from comparison of toxicity QSARs [13] with solubility behaviour that both paraffinic and naphthenic hydrocarbons in the range of C_{15} to C_{50} are too water insoluble to cause acute aquatic toxicity. Alkylbenzenes above a carbon number of C_{14} (n-octylbenzene) are also too insoluble to cause toxicity [14]. Moreover, the small proportion of higher molecular weight aromatics would be expected to remain primarily in the oil phase rather than in water when the two phases are in contact.

4. Bioaccumulation

No studies were identified which attempt to measure the BCF or log K_{ow} values of base oils. Further, such studies would not be meaningful, since each individual component of these complex substances will have its own values for these parameters.

From the carbon number range of the hydrocarbon constituents, it may be deduced that the log K_{ow} range of these substances will extend from 4 to over 6. Accordingly, highly refined base oils are presumed to have the potential to bioaccumulate, although in practice, metabolic processes may reduce the bioconcentration observed.

5. Biodegradability

There are 14 ready biodegradability studies available for 6 base oils in this group. These were all modified Sturm tests and they gave 28-day biodegradabilities covering the range of 5% to 26% [3,15]. The biodegradability of these base oils tended to decrease as their viscosities increased. The results show that these base oils do not meet the criteria for ready biodegradability. The same oil samples showed higher primary biodegradabilities in the CEC L-33-A-93 tests [15].

The hydrocarbon components of these base oils of are expected to be inherently biodegradable as micro-organisms capable of utilising such hydrocarbons are widespread in nature [16].

6. Environmental Fate

The low vapour pressures of these base oils indicate that volatilisation will not be a very significant fate process. In water, they will float and spread over the surface at a rate dependent upon viscosity. There will be significant removal of base oil components from the water column by sediment adsorption. In soil, base oil components will show low mobility with adsorption the predominant physical process. The main fate process is expected to be slow biodegradation of base oil components both in soil and sediment.

7. References

1. CONCAWE (1997) Lubricating oil basestocks. Product Dossier No. 97/108. Brussels: CONCAWE

2. Barbieri, J.F. et al (1993) Acute and chronic toxicity of petroleum base stocks to aquatic organisms. Paper presented at the 14th annual meeting of the Society of environmental toxicology and chemistry, November 14-18, 1993, Houston TX

3. BP (1984-1991) In-house company data. London: British Petroleum Company

4. Shell Research (1994) Base oils: chronic toxicity of water-accommodated fractions of CAS Numbers 64742-65-0, 64742-55-8, 64741-88-4 and 64742-53-6 to *Daphnia magna*. Report No. SBER.94.001. Sittingbourne: Shell Research Ltd.

5. BP (1995) PSG 1871: *Daphnia magna* reproduction test. Study conducted by Safepharm Laboratories Ltd. Project No. 692/038. Brussels: BP Oil Europe

6. BP (1995) PSG 1872: *Daphnia magna* reproduction test. Study conducted by Safepharm Laboratories Ltd. Project No. 692/039. Brussels: BP Oil Europe

7. BP (1995) PSG 1873: *Daphnia magna* reproduction test. Study conducted by Safepharm Laboratories Ltd. Project No. 692/040. Brussels: BP Oil Europe

8. BP (1995) PSG 1869: *Daphnia magna* reproduction test. Study conducted by Safepharm Laboratories Ltd. Project No. 692/036. Brussels: BP Oil Europe

9. BP (1995) PSG 1870: *Daphnia magna* reproduction test. Study conducted by Safepharm Laboratories Ltd. Project No. 692/037. Brussels: BP Oil Europe

10. BP (1995) PSG 1874: *Daphnia magna* reproduction test. Study conducted by Safepharm Laboratories Ltd. Project No. 692/041. Brussels: BP Oil Europe

11. BP (1995) PSG 1875: *Daphnia magna* reproduction test. Study conducted by Safepharm Laboratories Ltd. Project No. 692/042. Brussels: BP Oil Europe

12. Adema, D.M.M. and van den Bos Bakker, G.H. (1986) Aquatic toxicity of compounds that may be carried by ships (Marpol 1973, Annex II). A progress report for 1986 from TNO to the Dutch Ministry of Housing, Physical Planning and the Environment. Report No. 86/326a. Delft: TNO

13. EU (1996) Technical guidance document in support of Commission Directive 93/67/EEC on risk assessment for new notified substances and Commission Regulation (EC) 1488/94 on risk assessment for existing substances. Part II, Chapter 3, Appendix IX: Environmental risk assessment for petroleum substances. Luxembourg: Office for Official Publications of the European Communities

14. Adema, D.M.M. (1991) The acute toxicity of alkylbenzenes. Progress report no. 1 for 1990 and 1991 from TNO to the Dutch Ministry of Housing, Physical Planning and the Environment. Report No. 91/198. Delft: TNO

15. Battersby, N.S. et al (1992) A correlation between the biodegradability of oil products in the CEC L-33-T-82 and modified Sturm tests. *Chemosphere 24, 12, 1989-2000*

16. Atlas, R.M. (1984) Petroleum microbiology. New York: Macmillan Publishing Co.

APPENDIX 11

RESIDUAL AROMATIC EXTRACTS

1. Description

Residual aromatic extracts are obtained by solvent extraction of the residue remaining after the vacuum distillation of crude oil. After extraction, the solvent is removed by distillation leaving the residual aromatic extract.

EINECS contains two entries for residual aromatic extracts.

For labelling purposes the recommended short name is “residual aromatic extract”.

2. Composition/Properties

Residual aromatic extracts are complex and variable mixtures of hydrocarbons, the predominant generic type being aromatic hydrocarbons. They consist of high molecular weight hydrocarbons having carbon numbers of C_{25} and above.

Typical properties of residual aromatic extracts are summarised in **Table 1.**

Table 1: Summary of properties of residual aromatic extracts [1]

Property	Range of values
Aromatic hydrocarbons (% $^{w}/_{w}$)	60-80
Boiling range (°C)	>380
Density at 15°C (g/ml)	0.96-1.02
Pour point (°C)	> 20

3. Ecotoxicity

3.1 Experimental data

Four valid acute toxicity studies are available for residual aromatic extracts. Three of the studies were run with residual oil solvent extract (CAS No. 64742-10-5) and the fourth study (with fish species *Brachydanio rerio)* was run with deasphalted vacuum residue solvent extract (CAS No. 91995-70-9). The results are summarised in **Table 2**.

Table 2: Acute toxicity data for residual aromatic extracts using WAF method

Species	Parameter	Results (mg/l)	References
Fish (*Oncorhynchus mykiss*)	LL_{50}, 96h	>1000	[2]
Fish (*Brachydanio rerio*)	LL_{50}, 96h	>1000	[3]
Invertebrate *(Daphnia magna)*	EL_{50}, 48h	>1000	[4]
Algae (*Scenedesmus subspicatus*)	I_rL_{50}, 72h	>1000	[5]

In addition to the algal study referred to in **Table 2** from which NOEL values may be derived, one valid chronic toxicity study is available for residual oil solvent extract (CAS No 64742-10-5), the results for which are summarised in **Table 3**.

Table 3: Chronic toxicity data for residual aromatic extracts.

Species	Method	Exposure Period (days)	Endpoints	NOEL(mg/l)	Reference
Invertebrate *(Daphnia magna)*	WAF	21	Survival, reproduction rate	>1000	[6]

3.2 Predicted toxicity

Since residual aromatic extracts consist mainly of hydrocarbons of carbon number C_{25} and above, from the work of Adema [7,8] they would be expected to have such low water solubilities that no acute toxicity to fish, *Daphnia* and algae would result and this is borne out in the results of the reported studies.

The absence of chronic toxicity would also be predicted from QSAR data for the hydrocarbons contained in residual aromatic extracts.

4. Bioaccumulation

There are no known studies attempting to measure the BCF or log K_{ow} values of residual aromatic extracts.

Since hydrocarbons of carbon number C_{25} and above have log K_{ow} values above 5, residual aromatic extracts have the potential to bioaccumulate, although in practice, metabolic processes may reduce the bioconcentration observed.

5. Biodegradation

There are no known ready biodegradability studies for residual aromatic extracts.

In a primary biodegradability study using the CEC L-33-A-93 procedure, 30% of residual oil solvent extract (CAS No. 64742-10-5) was lost in the 21 day test period.

Residual aromatic extracts are regarded as being inherently biodegradable, but not readily biodegradable.

6. Environmental fate

Residual aromatic extracts are non-volatile and on release to water, adsorption on sediment followed by slow biodegradation is the most likely fate process. In soil, residual aromatic extracts will show little mobility and adsorption will be the main physical process followed by slow biodegradation.

7. References

1. CONCAWE (1992) Aromatic extracts. Product Dossier No. 92/101. Brussels: CONCAWE

2. BP (1994) The acute toxicity of PSG 1857 (CAS No. 64742-10-5) to rainbow trout (*Oncorhynchus mykiss*). Study conducted by Safepharm Laboratories Ltd. Project No. 599/44. Brussels: BP Oil Europe

3. TOTAL (1997) Toxicité aiguë de la substance EXTRAIT 5 (CAS No. 91995-70-9) vis-à-vis du poisson *Brachydanio rerio*. Méthode: ligne directrice 203 de l'OCDE. Adaptation aux produits pétroliers selon la méthodologie des "WAF". Etude effectuée par l'INERIS No. Ba 572. Harfleur: TOTAL Centre de Recherches

4. BP (1994) The acute toxicity of PSG 1857 (CAS No. 64742-10-5) to *Daphnia magna*. Study conducted by Safepharm Laboratories Ltd. Project No. 599/43. Brussels: BP Oil Europe

5. BP (1994) PSG 1857 (CAS No. 64742-10-5): algal inhibition test. Study conducted by Safepharm Laboratories Ltd. Project No. 599/42. Brussels: BP Oil Europe

6. BP (1995) Assessment of the effect of PSG 1857 (CAS No. 64742-10-5) on the reproduction of *Daphnia magna*. Study conducted by Safepharm Laboratories Ltd. Project No. 692/6. Brussels: BP Oil Europe

7. Adema, D.M.M. (1991) The acute toxicity of alkylbenzenes. Progress report no. 1 for 1990 and 1991 from TNO to the Dutch Ministry of Housing, Physical Planning and the Environment. Report No. 91/198. Delft: TNO

8. Adema, D.M.M. and van den Bos Bakker, G.H. (1986) Aquatic toxicity of compounds that may be carried by ships (Marpol 1973, Annex II). A progress report for 1986 from TNO to the Dutch Ministry of Housing, Physical Planning and the Environment. Report No. 86/326a. Delft: TNO

APPENDIX 12

UNTREATED DISTILLATE AROMATIC EXTRACTS

1. Description

Untreated distillate aromatic extracts are obtained by solvent extraction of the distillates obtained from the vacuum distillation of crude oil. Following extraction, the solvent is removed by distillation leaving the aromatic extract.

EINECS contains 6 entries for untreated distillate aromatic extracts.

For labelling purposes, these substances have been assigned the short-name “distillate aromatic extract”.

2. Composition/Properties

Untreated distillate aromatic extracts are complex and variable mixtures, consisting predominantly of aromatic hydrocarbons. They contain hydrocarbons in the carbon number range C_{13} to C_{55}. Heterocyclic compounds containing sulphur and nitrogen are also found in minor amounts in these petroleum substances.

Typical properties of untreated distillate aromatic extracts are summarised in **Table 1**.

Table 1: Summary of properties of untreated distillate aromatic extracts [1]

Property	Range of values
Aromatic hydrocarbons (% $^{w}/_{w}$)	65-85
Boiling range (°C)	250-680
Density at 15°C (g/ml)	0.95-1.03
Pour point (°C)	-6 to 36

3. Ecotoxicity data

3.1 Experimental data

Acute toxicity data for untreated distillate aromatic extracts embracing 4 studies are summarised in **Table 2.**

Table 2: Acute toxicity data for untreated distillate aromatic extracts

Species	Method	Parameter	Results (mg/l)	References
Fish (*Salmo gairdneri*)	OWD	LL_{50}, 96h	>1000	[2]
Fish (*Oncorhynchus mykiss*)	WAF	LL_{50}, 96h	>1000	[3]
Invertebrate *(Daphnia magna)*	OWD	EL_{50}, 48h	1.4	[2]
Invertebrate *(Daphnia magna)*	WAF	EL_{50}, 48h	>1000	[4]

There is one chronic toxicity study for untreated distillate aromatic extracts and the result is summarised in **Table 3**.

Table 3: Results of chronic toxicity studies on untreated distillate aromatic extracts.

Species	Method	Exposure Period (days)	Endpoint	NOEL (mg/l)	References
Invertebrate *(Daphnia magna)*	WAF	21	survival, reproduction rate	>1000	[5]

3.2 Predicted toxicity

Since untreated distillate aromatic extracts consist primarily of hydrocarbons in the carbon number range C_{13} to C_{55}, from the work of Adema [6,7] they would be expected to have such low water solubilities that no acute toxicity to fish, *Daphnia* and algae would result. This is borne out in studies on fish and *Daphnia* where WAFs have been used. However, there is no method of predicting the toxicities of untreated distillate aromatic extracts in tests where the insoluble phase is present, since these studies are considered to measure physical toxicity rather than the inherent toxicity of the substances concerned.

4. Bioaccumulation

There are no known studies attempting to measure the BCF values of untreated distillate aromatic extracts.

One study [2] has been run to determine the octanol/water partition coefficient of a light naphthenic distillate solvent extract (CAS No. 64742-03-6) using reverse phase HPLC and this gave a log K_{ow} range of 4.4 to 7.2. The latter figures indicate that untreated distillate aromatic extracts have the potential to bioaccumulate, although in practice, metabolic processes may reduce the bioconcentration observed.

5. Biodegradation

Ready biodegradability tests [8] have been run on a light naphthenic distillate aromatic extract (CAS No. 64742-03-06) using the closed bottle (OECD 301D) and modified Sturm (OECD 301B) procedures. In both cases, no biodegradation was observed. In two 21-day tests[9] of primary biodegradability using the CEC L-33-A-93 procedure, 16% and 26% of a heavy paraffinic distillate solvent extract (CAS No. 64742-04-7) were removed. Overall,

untreated distillate aromatic extracts are expected to be inherently biodegradable, but not readily biodegradable.

In a standard Microtox test [2], at the highest loading rate of 1000 mg/l, the inhibition of growth rate for *Pseudomonas fluorescens* from the presence of light naphthenic distillate solvent extract (CAS No. 64742-03-6) was 20% indicating that this substance was not particularly toxic to bacteria.

6. Environmental fate

The constituents of untreated distillate aromatic extracts have negligible vapour pressure at ambient temperatures and hence, volatility is not a significant loss process for these substances. Where releases to water occur, the main physical process is adsorption to sediment followed by slow biodegradation. In soil, these substances will have limited mobility and the main physical process will be adsorption followed by slow biodegradation.

7. References

1. CONCAWE (1992) Aromatic extracts. Product Dossier No. 92/101. Brussels: CONCAWE

2. Shell Research (1994) DUTREX 478FC (CAS No. 64742-03-6): acute toxicity to *Salmo gairdneri*, *Daphnia magna* and *Selenastrum capricornutum*; N-octanol/water partition coefficient. Report No. SBER.93.009. Sittingbourne: Shell Research Ltd.

3. BP (1994) The acute toxicity of PSG 1860 (CAS No. 64742-04-7) to rainbow trout (*Oncorhynchus mykiss*). Study conducted by Safepharm Laboratories Ltd. Project No. 692/11. Brussels: BP Oil Europe

4. BP (1994) The acute toxicity of PSG 1860 (CAS No. 64742-04-7) to *Daphnia magna*. Study conducted by Safepharm Laboratories Ltd. Project No. 692/10. Brussels: BP Oil Europe

5. BP (1995) Assessment of the effect of PSG 1860 (CAS No. 64742-04-7) on the reproduction of *Daphnia magna*. Study conducted by Safepharm Laboratories Ltd. Project No. 692/12. Brussels: BP Oil Europe

6. Adema, D.M.M. (1991) The acute toxicity of alkylbenzenes. Progress report no. 1 for 1990 and 1991 from TNO to the Dutch Ministry of Housing, Physical Planning and the Environment. Report No. 91/198. Delft: TNO

7. Adema, D.M.M. and van den Bos Bakker, G.H. (1986) Aquatic toxicity of compounds that may be carried by ships (Marpol 1973, Annex II). A progress report for 1986 from TNO to the Dutch Ministry of Housing, Physical Planning and the Environment. Report No. 86/326a. Delft: TNO

8. Shell Research (1994) DUTREX 478FC (CAS No. 64742-03-6): an assessment of “ready biodegradability”. Report No. SBER.93.012. Sittingbourne: Shell Research Ltd.

9. BP (1997) BP Oil aquatic toxicity data for aromatic extracts. Brussels: BP Oil Europe

APPENDIX 13

TREATED DISTILLATE AROMATIC EXTRACTS

1. Description

Treated distillate aromatic extracts are obtained by subjecting untreated distillate aromatic extracts to various processes, in particular catalytic hydrogenation and solvent extraction.

EINECS contains entries for 19 treated distillate aromatic extracts.

For labelling purposes, the short name assigned to these substances is “distillate aromatic extract (treated)”.

2. Composition/Properties

Treated distillate aromatic extracts are complex and variable mixtures, consisting mainly of aromatic hydrocarbons. They contain hydrocarbons having carbon numbers in the range C_{13} to C_{50}. Heterocyclic compounds containing sulphur and nitrogen are also found in minor amounts in these petroleum substances.

Typical properties of treated distillate aromatic extracts are summarised in **Table 1.**

Table 1: Summary of properties of treated distillate aromatic extracts [1,2]

Property	Range of values
Aromatic hydrocarbons (% $^{w}/_{w}$)	68-75
Density at 15°C (g/ml)	0.93-0.95
Pour point (°C)	10-24

3. Ecotoxicity

3.1 Experimental data

Two valid ecotoxicity studies have been identified, both run on a solvent-extracted distillate aromatic extract (CAS No. 68783-04-0).

The results are given in **Table 2.**

Table 2: Acute toxicity data for treated distillate aromatic extracts using WAF method

Species	Parameter	Results (mg/l)	Reference
Fish (*Oncorhynchus mykiss*)	LL_{50}, 96h	>1000	[3]
Invertebrate *(Daphnia magna)*	EL_{50}, 48h	>1000	[4]

One chronic toxicity study has also been run on the same solvent-extracted distillate aromatic extract (CAS No. 68783-04-0). The data are summarised in **Table 3.**

Table 3: Chronic toxicity data on treated distillate aromatic extracts using WAF method

Species	Exposure Period (days)	Endpoints	NOEL (mg/l)	Reference
Invertebrate *(Daphnia magna)*	21	survival, reproduction rate	1000	[5]

3.2 Predicted toxicity

It is predictable from the work of Adema [6,7] that the hydrocarbon constituents of substances in this group will have such low water solubilities that no acute toxicities would be observed in practice.

4. Bioaccumulation

There are no known studies attempting to measure either the BCF or log K_{ow} values of treated distillate aromatic extracts.

From the known carbon number range of the hydrocarbons constituting treated distillate aromatic extracts, it may be deduced that the log K_{ow} range for these substances will extend from 4 to over 6. Accordingly, treated distillate aromatic extracts have the potential to bioaccumulate, although in practice, metabolic processes may reduce the bioconcentration observed.

5. Biodegradation

There are no known ready biodegradability studies for treated distillate aromatic extracts.

A primary biodegradability study [7] was run to the CEC L-33-A-93 procedure and this resulted in 37% of the original substance being lost in the 21 days of the test.

Treated distillate aromatic extracts are regarded as containing components that are inherently biodegradable, but not readily biodegradable.

6. Environmental fate

Since the constituents of treated distillate aromatic extracts have negligible vapour pressure at ambient temperatures, volatility is not a significant loss process for these substances. Where releases to water occur, most of the constituents of these substances will be adsorbed on sediment following which slow biodegradation will occur. In soil these substances will show little mobility and the main physical process will be adsorption followed by slow biodegradation.

7. References

1. Doak, S.M.A. et al (1985) Carcinogenic potential of hydrotreated petroleum aromatic extracts. *Brit J Ind Med 42, 380-388*

2. BP (1997) BP Oil aquatic toxicity data for aromatic extracts. Brussels: BP Oil Europe

3. BP (1994) The acute toxicity of PSG 1861 (CAS No. 68783-04-0) to rainbow trout (*Oncorhynchus mykiss*). Study conducted by Safepharm Laboratories Ltd. Project No. 692/14. Brussels: BP Oil Europe

4. BP (1994) The acute toxicity of PSG 1861 (CAS No. 68783-04-0) to *Daphnia magna.* Study conducted by Safepharm Laboratories Ltd. Project No. 692/13. Brussels: BP Oil Europe

5. BP (1995) Assessment of the effect of PSG 1861 (CAS No. 687783-04-0) on the reproduction of *Daphnia magna*. Study conducted by Safepharm Laboratories Ltd. Project No. 692/15. Brussels: BP Oil Europe

6. Adema, D.M.M. (1991) The acute toxicity of alkylbenzenes. Progress report no. 1 for 1990 and 1991 from TNO to the Dutch Ministry of Housing, Physical Planning and the Environment. Report No. 91/198. Delft: TNO

7. Adema, D.M.M. and van den Bos Bakker, G.H. (1986) Aquatic toxicity of compounds that may be carried by ships (Marpol 1973, Annex II). A progress report for 1986 from TNO to the Dutch Ministry of Housing, Physical Planning and the Environment. Report No. 86/326a. Delft: TNO

APPENDIX 14

OTHER AROMATIC EXTRACTS

1. Description

This is a grouping of aromatic extracts, mainly derived from the solvent extraction of middle distillates. An exception is CAS No. 97488-75-0 which is a solvent extract of a hydrocracked residue.

A total of 15 EINECS entries constitute this group.

For labelling purposes, the recommended short name for this group is “aromatic extract – unspecified”.

2. Composition/Properties

The aromatic extracts in this group are complex and variable mixtures of hydrocarbons, the predominant generic type being aromatic hydrocarbons. From the substance definitions, most of the hydrocarbon constituents have carbon numbers in the range C_9 to C_{30}.

There are no known published data on the physico-chemical properties or the compositions of substances in this group.

3. Ecotoxicity

There are no known experimental ecotoxicity data for substances in this group.

From compositional considerations, some of the lower molecular weight hydrocarbons contained in certain substances in this group may cause acute toxicity in the standard tests. These conclusions are based on the studies of Adema [1,2].

4. Bioaccumulation

There are no known studies to find the BCF or log K_{ow} values of the aromatic extracts in this group.

Calculated and/or measured log K_{ow} values for the hydrocarbons found in substances in this group range from 3.3 to over 6. Accordingly, these aromatic extracts have the potential to bioaccumulate, although in practice, metabolic processes may reduce the bioaccumulation observed.

5. Biodegradation

There are no known biodegradation studies relating to substances in this group.

As for other aromatic extracts, substances in this group would be expected to be inherently biodegradable, but not readily biodegradable.

6. Environmental fate

On release to the environment, some of the lower molecular weight hydrocarbons contained in these aromatic extracts will partition to air, where they will react with hydroxyl radicals. Their half-lives in air are likely to be less than one day [3]. However, most of the hydrocarbons in these aromatic extracts will preferentially distribute to soil and sediment where the predominant physical process will be adsorption followed by gradual biodegradation.

7. References

1. Adema, D.M.M. (1991) The acute toxicity of alkylbenzenes. Progress report no. 1 for 1990 and 1991 from TNO to the Dutch Ministry of Housing, Physical Planning and the Environment. Report No. 91/198. Delft: TNO

2. Adema, D.M.M. and van den Bos Bakker, G.H. (1986) Aquatic toxicity of compounds that may be carried by ships (Marpol 1973, Annex II). A progress report for 1986 from TNO to the Dutch Ministry of Housing, Physical Planning and the Environment. Report No. 86/326a. Delft: TNO

3. Atkinson, R. (1990) Gas-phase tropospheric chemistry of organic compounds: a review. *Atmos Environ 24A, 1-41*

APPENDIX 15

PETROLEUM AND HYDROCARBON WAXES

1. Description

Petroleum waxes are solid materials obtained by vacuum distillation of crude oil. They are recovered from both the distillates and residues by various refining processes. EINECS contains entries for 22 petroleum waxes and they may be divided into 3 types (paraffin, microcrystalline and intermediate waxes).

For labelling purposes, the recommended short name for substances in this group is “petroleum wax”.

2. Composition/Properties

Typical compositions and properties are given in **Table 1**.

Table 1: Compositions and properties of petroleum waxes [1,2]

	Paraffin waxes	**Intermediate waxes**	**Microcrystalline waxes**
Composition	Alkanes, mainly n-alkanes	Alkanes, n-, iso- and cycloalkanes	Alkanes, mainly iso- and cycloalkanes
Carbon number range	C_{20}-C_{50}	C_{20}-C_{60}	C_{25}-C_{85}
Melting point range (°C)	43-65	ND	63-90
Density range at 15°C (g/ml)	0.88-0.915	ND	0.90-0.94
Viscosity at 100°C (mm^2/s)	3-6	6-10	10-30

ND = No Data

3. Ecotoxicity

There are no known experimental ecotoxicity data for petroleum waxes. However, from the work of Adema and van den Bos Bakker [3] on n-alkanes, it is known that for this homologous series of hydrocarbons, the aqueous solubility of hydrocarbons above carbon number C_{10} is too low for aquatic toxicity to be observed in studies involving exposures of the invertebrates, *Daphnia magna* and *Chaetogammarus marinus* to water accommodated fractions of these substances. Accordingly, the much lower aquatic solubilities of alkanes of C_{20} and above are such that petroleum and hydrocarbon waxes would not be acutely toxic to aquatic organisms.

Whilst there are no known chronic ecotoxicity studies for petroleum waxes, by inference from studies on lubricant base oils [4], they would not be expected to have sufficient water solubility to show chronic effects to aquatic organisms.

4. Bioaccumulation

There are no known experimental data relating to the determination of BCF or log K_{ow} values for the constituents of petroleum waxes. However, from structural considerations,

all the hydrocarbon components of waxes have log K_{ow} values in excess of 6 and hence, in theory, have the potential to bioaccumulate, although in practice, metabolic processes may reduce the bioconcentration observed.

5. Biodegradation

No ready biodegradability studies have been identified for petroleum waxes.

Inherent biodegradability studies [5] were performed on samples of paraffin wax (CAS No 8002-74-2), intermediate wax (CAS No 97489-05-9) and microcrystalline wax (CAS No 63231-60-7) using a modified Sturm procedure (OECD 301B) in which the materials were exposed on glass fibre filters. In these tests, the paraffin wax degraded by 81% after 28 days and by 87% after 84 days, the intermediate wax degraded by 66% after 28 days and by 77% after 84 days and the microcrystalline wax degraded by 21% after 28 days and by 25% after 84 days. It may be concluded that paraffin waxes are inherently biodegradable and may be readily biodegradable, intermediate waxes are inherently biodegradable and microcrystalline waxes contain hydrocarbons that are more resistant to biodegradation.

6. Environmental fate

The hydrocarbon components of paraffin waxes have negligible vapour pressures at ambient temperatures and hence, volatility is not a significant fate process for these petroleum substances.

In litter bag tests [6,7] performed on the same three samples as were used in the inherent biodegradability studies, paraffin and intermediate waxes were 100% degraded after three months exposure in woodland soil in autumn/winter. Under the same conditions, microcrystalline waxes were only 20% degraded after 6 months exposure, expressing the slower rate of biodegradation of these substances.

7. References

1. Anonymous (1984) Final report on the safety assessment of fossil and synthetic waxes. *J Am Coll Toxicol 3, 3, 43-99*

2. CONCAWE (1993) White oils and waxes - summary of 90-day studies. Report No. 93/56. Brussels: CONCAWE

3. Adema, D.M.M. and van den Bos Bakker, G.H. (1986) Aquatic toxicity of compounds that may be carried by ships (Marpol 1973, Annex II). A progress report for 1986 from TNO to the Dutch Ministry of Housing, Physical Planning and the Environment. Report No. 86/326a. Delft: TNO

4. CONCAWE (1997) Lubricating oil basestocks. Product Dossier No. 97/108. Brussels: CONCAWE

5. Hanstveit, A.O. (1990) Inherent biodegradability of waxes. Report No. 90/198b. Delft: TNO

6. Hanstveit, A.O. (1991) A study of the fate of waxed paper materials in a woodland litter layer. Report No. 90/243a. Delft: TNO

7. de Krenk, J.F. (1988) Protocol for the investigation of the biodegradability of ten waxed samples and the environmental fate of waxed packaging materials. Protocol No. GLP 88/150. Delft: TNO

APPENDIX 16

FOOTS OILS

1. Description

Foots oils are semi-solid waxy materials obtained by the de-oiling of slack waxes. The resulting products may be further treated to remove polar compounds and other impurities EINECS contains entries for 5 foots oils.

For labelling purposes, the short name assigned to this group of substances is “foots oil”.

2. Composition / Properties

Foots oils consist predominantly of branched-chain alkanes having carbon numbers in the range C_{20} to C_{50}.

Available data on the physico-chemical properties of foots oils are summarised in **Table 1.**

Table 1: Typical properties of foots oils (CAS No. 64742-67-2***)***

Property	Value
Melting point (°C)	36-45
Boiling range (°C)	350-520
Density (g/ml at 70°C)	0.80-0.85
Flash point (closed cup) (°C)	> 200

3. Ecotoxicity data

There are no known experimental ecotoxicity data for foots oils. However, since they mainly contain branched-chain alkanes, the behaviour of these hydrocarbons in water will resemble that of the n-alkanes that have been studied by Adema and van den Bos Bakker [1]. These authors showed that for n-alkanes of carbon number C_{10} and above, the aqueous solubilities were too low for acute aquatic toxicity to be observed in studies involving exposures of the invertebrates, *Daphnia magna* and *Chaetogamarus marinus* to water accommodated fractions of these substances. Accordingly, the much lower aquatic solubilities of alkanes of C_{20} and above are such that they would not be acutely toxic to aquatic organisms.

Whilst there are no known chronic ecotoxicity studies for foots oils, by inference from studies on lubricant base oils [2], foots oils would not be expected to have sufficient water solubility to show chronic effects to aquatic organisms.

4. Bioaccumulation

There are no known experimental data relating to the determination of BCF or log K_{ow} values for foots oils or their constituent hydrocarbons. However, from structural considerations, all the hydrocarbon components of foots oils have log K_{ow} values above 6 and hence, in theory, have the ability to bioaccumulate, although in practice, metabolic processes may reduce the bioconcentration observed.

5. Biodegradation

No ready biodegradability studies have been identified for foots oils.

It is known that branched-chain alkanes are more resistant to biodegradation in aquatic systems than are n-alkanes. Accordingly, foots oils are regarded as being inherently biodegradable in water.

6. Environmental fate

The hydrocarbon components of foots oils have negligible vapour pressures at ambient temperature and hence, volatility is not a significant fate process for these substances.

Environmental releases of foots oils to water will mainly result in the hydrocarbons being adsorbed on to sediment, followed by slow biodegradation. On release to soil, foots oils are not mobile and the hydrocarbon constituents will be adsorbed on particles and will undergo gradual biodegradation.

7. References

1. Adema, D.M.M. and van den Bos Bakker, G.H. (1986) Aquatic toxicity of compounds that may be carried by ships (Marpol 1973, Annex II). A progress report for 1986 from TNO to the Dutch Ministry of Housing, Physical Planning and the Environment. Report No. 86/326a. Delft: TNO

2. CONCAWE (1997) Lubricating oil basestocks. Product Dossier No. 97/108. Brussels: CONCAWE

APPENDIX 17

SLACK WAXES

1. Description

Slack waxes are very soft solids obtained from paraffinic vacuum distillates, either by cooling or by solvent crystallisation. In modern practice, slack waxes are obtained following solvent extraction of the vacuum distillate to remove the aromatic hydrocarbons.

Slack waxes are often subjected to further treatments to remove polar constituents and other unwanted constituents.

EINECS contains entries for 10 slack waxes.

For labelling purposes, these substances have been assigned the short name of “slack wax”.

2. Composition / Properties

Slack waxes are essentially mixtures of paraffin waxes (75-95%) and mineral oils (5-25%). In subsequent de-oiling processes, slack waxes yield paraffin waxes and foots oils.

Slack waxes consist predominantly of straight-chain and branched-chain alkanes having carbon numbers from C_{12} to C_{50}.

Collected data on the physico-chemical properties of slack waxes are very rare. Warth [1] reports that a typical melting point range for slack waxes is 57 to 63°C.

3. Ecotoxicity

There are no known experimental ecotoxicity data for slack waxes. However, since they contain alkanes of carbon number C_{12} and above, it is clear from the work of Adema and van den Bos Bakker [2] using water accommodated fractions of n-alkanes, that the aqueous solubilities of these components are too low to cause acute toxicity to aquatic organisms. Similarly, by inference from the chronic ecotoxicity studies that have been conducted on lubricant base oils [3], slack waxes would not be expected to cause chronic effects in aquatic organisms.

4. Bioaccumulation

There are no known experimental data relating to the determination of BCF or log K_{ow} values for slack waxes. However, all the hydrocarbon constituents of slack waxes have log K_{ow} values above 6 and hence, in theory, have the ability to bioaccumulate, although in practice, metabolic processes may reduce the bioconcentration observed.

5. Biodegradation

Battersby *et al* [4,5] reported 28-day ready biodegradability studies on three samples of hydrotreated slack wax (CAS No. 92062-09-4) of different viscosities using the modified Sturm method (OECD guideline 301B). All the samples were emulsified in the test medium using a hard anionic surfactant. The observed biodegradabilities were 26%, 41%

and 48% indicating that these substances are inherently biodegradable but not readily biodegradable in water.

For comparison, the same three samples were also evaluated in 21-day primary biodegradability studies using the CEC L-33-T-82 procedure. The observed results were 50%, 60% and 73% expressing the extent of loss of the starting material.

6. Environmental fate

The environmental release of slack waxes will result in volatilisation of any low molecular weight hydrocarbons that may be present. These constituents will react with hydroxyl radicals [6] and their half lives in air will be less than one day. The vast majority of slack wax components will partition to soil and sediment. Following adsorption, they will slowly biodegrade in these environments.

7. References

1. Warth, A.H. (1960) The chemistry and technology of waxes. New York: Reinhold

2. Adema, D.M.M. and van den Bos Bakker, G.H. (1986) Aquatic toxicity of compounds that may be carried by ships (Marpol 1973, Annex II). A progress report for 1986 from TNO to the Dutch Ministry of Housing, Physical Planning and the Environment. Report No. 86/326a. Delft: TNO

3. CONCAWE (1997) Lubricating oil basestocks. Product Dossier No. 97/108. Brussels: CONCAWE

4. Battersby, N.S. et al (1992) A correlation between the biodegradability of oil products in the CEC L-33-T-82 and modified Sturm tests. *Chemosphere 24, 12, 1989-2000*

5. Battersby, N.S. (1993) Personal communication, 3 September, 1993

6. Atkinson, R. (1990) Gas-phase tropospheric chemistry of organic compounds: a review. *Atmos Environ 24A, 1-41*

APPENDIX 18

PETROLATUMS

1. Description

Petrolatums are soft, semi-solid materials obtained by the solvent dewaxing of paraffinic residual oils. The initial materials may be further refined to remove minor quantities of polar constituents that are present and also improve the colour of the final products.

EINECS contains entries for 7 petrolatums.

For labelling purposes, these substances have been assigned the short name of "petrolatum".

2. Composition / Properties

Petrolatums consist of microcrystalline waxes and paraffinic mineral oils; chemically, they contain straight-chain, branched-chain and cyclo-alkanes in the carbon number range C_{20} to C_{85}. An exception is oxidised petrolatum (CAS No. 64743-01-7) which also contains high molecular weight carboxylic acids.

Very few data are available on the physico-chemical properties of petrolatums. Warth [1] records that a typical melting point range is 36 to 60°C and that densities measured at 60°C range from 0.815 to 0.865 g/cm^3. Other important parameters are colour and penetration index.

3. Ecotoxicity data

There are no known experimental ecotoxicity data for petrolatums. However, since they mainly consist of normal, branched and cycloalkanes of carbon numbers C_{20} and above, it is evident from the work of Adema and van den Bos Bakker [2] that these materials have aqueous solubilities which are far too low to cause acute toxicity to aquatic organisms. Also, by inference from studies on lubricant base oils [3], petrolatums would not be expected to show chronic toxicity to aquatic organisms.

4. Bioaccumulation

There are no known experimental data relating to the determination of BCF or log K_{ow} values for petrolatums. However, all the hydrocarbon components of petrolatums have calculated log K_{ow} values above 6 and, hence, in theory, have the ability to bioaccumulate, although in practice, metabolic processes may reduce the bioconcentration observed.

5. Biodegradation

There are no known experimental biodegradability studies for petrolatums. Although the n-alkanes may be readily biodegradable, this will not be the case for the cycloalkanes and the branched-chain alkanes and overall, petrolatums are regarded as being inherently biodegradable, but not readily biodegradable in water.

6. Environmental Fate

On release to the environment, the components of petrolatums will show negligible tendency to volatilise. In water, they will mainly be removed by adsorption on sediment. In soil, petrolatums are immobile and the main physical process will be adsorption. Adsorbed petrolatums in both soil and sediment will undergo slow biodegradation.

7. References

1. Warth, A.H. (1960) The chemistry and technology of waxes. New York: Reinhold

2. Adema, D.M.M. and van den Bos Bakker, G.H. (1986) Aquatic toxicity of compounds that may be carried by ships (Marpol 1973, Annex II). A progress report for 1986 from TNO to the Dutch Ministry of Housing, Physical Planning and the Environment. Report No. 86/326a. Delft: TNO

3. CONCAWE (1997) Lubricating oil basestocks. Product Dossier No. 97/108. Brussels: CONCAWE

APPENDIX 19

USED OILS

1. Description

These substances are used lubricating oils, most of which started their existence as preparations consisting of base oils and additives.

The commonest type of used oil is that derived from automotive engines, but other sources include gear boxes, hydraulic systems, transformers and metalworking oil storage systems. EINECS identifies only one entry for used oil viz, CAS No. 70514-24-4 named as “used lubricating oils”.

For labelling purposes, the recommended short name is “used oil”.

The following paragraphs address the properties of used engine oils.

2. Composition / Properties

Used engine oils arise from both gasoline and diesel-powered vehicles, and their properties and compositions are a reflection of their original constituents and the contamination resulting from compounds synthesised in the fuel combustion processes that occur in the engines. Thus, used lubricants will contain some of the original additives, although these are likely to be significantly degraded and modified at their high temperatures of use; used engine oils also contain PAHs formed during combustion, fuel residues, wear metals, combustion products and water. Although primarily liquids, used oils contain significant amounts of suspended solids. Typical ranges of properties for used engine oils are given in **Table 1**.

Table 1: Typical composition / properties of used engine oils [1,2]

Parameter	Value
Density (g/ml at 20°C)	0.892-0.901
Viscosity (cSt at 98.9°C)	8.76-12.53
Sulphur (% m/m)	0.2-1
Fuel (% v/v)	5-10
Water (% m/m)	5-10
Zinc (mg/kg)	500-1000
Lead (mg/kg)	100-1000
Calcium (mg/kg)	1000-3000
Phosphorus (mg/kg)	500-1000

3. Ecotoxicity

3.1 Experimental data

Acute toxicity data for used oils are summarised in **Table 2**.

Table 2: Acute toxicity data for used engine oil samples

Species	Method	Parameter	Results (mg/l)	Reference
Fish (*Jordanella floridae*)	Flow through using OWD	LC_{50} (96h)	74	[3]
Invertebrate (*Artemia salina*)	WAF (in sea water)	EL_{50} (48h)	>22,500	[4]

There are no known chronic toxicity studies for used engine oil.

3.2 Predicted toxicity

From the information given in section 2, it is apparent that the compositions of used lubricating oils will be extremely variable, since in addition to the base oil hydrocarbons, they will contain the remnants of lubricant additives, combustion products, wear metals, fuel and water. Accordingly there are no satisfactory methods for calculating the water solubilities and hence, the predicted toxicities of these materials.

4. Bioaccumulation

There are no measured BCF or log K_{ow} values for used oils. However, the hydrocarbon constituents of the original base oils will have log K_{ow} values above 3 and hence, used oils can be expected to be potentially bioaccumulative. Used engine oils contain significant concentrations of wear metals and these may bioaccumulate in the environment.

5. Biodegradability

The biodegradability of used engine oils has not been studied. However, from the known properties of the hydrocarbon constituents of the original base oils, it is predicted that the hydrocarbon components of used oils will not be readily biodegradable, but will be inherently biodegradable. Similarly, the biodegradability of additives used in lubricating oil blends and their degradation products formed during use, has not been investigated.

6. Environmental fate

On release to the environment, the fuel components of used engine oils will largely be lost by volatilisation and will photodegrade in the atmosphere by reaction with hydroxyl radicals [5]. In water, used engine oils will float and spread. Loss by water dissolution is expected to be very low. Most of the hydrocarbon components are likely to be adsorbed on sediment and will ultimately be degraded by micro-organisms. In soil, used oils exhibit a range of mobilities largely depending on their viscosities, but the predominant physical process is adsorption followed by slow biodegradation of the organic components.

7. References

1. Koehn, H.O.A. (1987) Wohin mit dem alten Autoöl? *Abfallwirtschaft 7-8, 342-347*

2. CONCAWE (1996) Collection and disposal of used lubricating oil. Report No. 5/96. Brussels: CONCAWE

3. Hedtke, S.F. and Puglisi, F.A. (1982) Short-term toxicity of five oils to four freshwater species. *Arch Environ Contam Toxicol 11, 425-430*

4. MacLean , M.M. and Doe, K.G. (1989) The comparative toxicity of crude and refined oils to *Daphnia magna* and *Artemia*. Report No. EE-111. Ottawa: Environment Canada

5. Atkinson, R. (1990) Gas-phase tropospheric chemistry of organic compounds: a review. *Atmos Environ 24A, 1-41*

APPENDIX 20

REREFINED OILS

1. Description

Rerefined oils are obtained from used lubricating oils by a variety of processes [1] ranging from treatment with clay or acid through to vacuum distillation accompanied by solvent extraction or catalytic hydrogenation.

There are 12 entries in EINECS for rerefined oils.

For labelling purposes, the recommended short name for these substances is “rerefined oil”.

2. Composition/Properties

Rerefined oils consist principally of hydrocarbons having carbon numbers in the range C_{15} to C_{50}, but the extent of removal of any additives (e.g. organo-metallic compounds, methacrylate polymers etc.) and contaminants (wear metals, oxidation products etc.) that were present in the original used oil, will depend on the processing that they have undergone. In general, where a vacuum distillation step is involved, most of the additives and contaminants that are present in the used oil will not re-appear in the rerefined oils.

No data on the physical properties of typical rerefined oils were found.

3. Ecotoxicity

3.1 Experimental data

Data are available for a series of studies on hydrotreated spent lubricating oil (CAS No. 64742-58-1). Four samples of different viscosities were studied. In these tests, different loading rates were used, but the aqueous phase was not separated and a floating layer of oil was always present on the surface of the water. The results were undoubtedly influenced by the presence of this insoluble phase and hence, are of doubtful validity. The data are summarised in **Table 1**.

***Table 1**:* Acute toxicity data for samples of rerefined oil (CAS No. 64742-58-1)

Species	Method	Parameter	Results (mg/l)	Reference
Fish *(Brachydanio rerio)*	Floating layer on water (semi-static)	LL_{50}, 96 h	1.3 - 79.6 (4 studies)	[2]
Invertebrate (Daphnia magna)	Solvent solutions added to water	EL_{50}, 48h	2.3 - 2.5 (4 studies)	[3]

3.2 Predicted toxicity

For the prediction of the toxicity of rerefined oils, they are sub-divided into two groups as follows:

- For rerefined oils produced by vacuum distillation followed by further treatment e.g. solvent extraction or hydrogenation, the toxicity of the resulting C_{15} to C_{50} hydrocarbons will be the same as for the lubricant base oils considered in **Appendix 10** i.e. these oils would not cause acute or chronic toxicity.

- For rerefined oils not produced by vacuum distillation, their toxicity will depend on the properties of the residual additives and contaminants that they contain and no general conclusions can be drawn on their ecotoxicological effects.

4. Bioaccumulation

There are no measured BCF or log K_{ow} values for rerefined oils. However, the hydrocarbon constituents of these oils will have log K_{ow} values above 3 and hence, rerefined oils are regarded as potentially bioaccummulative.

5. Biodegradability

In 28-day closed bottle tests [4] conducted to OECD guideline 301D, two samples of hydrotreated spent lubricating oil, CAS No. 64742-58-1 were biodegraded by 6.7% and 9.1%. The results for these samples show that they are clearly not readily biodegradable.

6. Environmental fate

On release to water, rerefined oils will float and spread. Loss by volatilisation and by water dissolution will be negligible. Most of the hydrocarbons will be adsorbed on sediment and will ultimately be degraded by micro-organisms. In soil, the mobility of rerefined oils will depend on their viscosities, but this will not normally be significant. The main physical process will be adsorption with gradual loss by biodegradation.

7. References

1. CONCAWE (1996) Collection and disposal of used lubricating oil. Report No. 5/96. Brussels: CONCAWE

2. AGIP Petroli (1994) NR150, NR400, BR, NR95 - Acute toxicity study in fish (semi-static test). Report Nos. 930805, 930813, 930821, 930797. In-house company data

3. AGIP Petroli (1994) NR95, NR150, NR400, BR - Acute immobilisation study in *Daphnia magna*. Report Nos. 930798, 930806, 930814, 930822. In-house company data

4. AGIP Petroli (1994) NR95, NR150 - Ready biodegradability (closed bottle test). Report Nos. 930799, 930807. In-house company data

APPENDIX 21

BITUMENS

1. Description

Bitumens are obtained as the residues from the vacuum distillation (and possible oxidation step by “blowing” with air) of crude oil. They vary considerably with the nature of the crude oil and can themselves be further treated to give different types of bitumens. For classification and risk assessment purposes [1], 9 entries in EINECS have been associated with the bitumen group of petroleum substances.

For labelling purposes, the recommended short name is “bitumen or vacuum residue”.

2. Composition/Properties

Bitumens consist mainly of hydrocarbons of carbon number C_{25} and above, together with smaller amounts of sulphur and nitrogen containing heterocyclic compounds and organo-metallic complexes. The principal hydrocarbon types [2] are as follows:

- cycloalkanes and cycloaromatics (45-60%)
- resins, largely polar aromatic compounds (15-25%)
- asphaltenes, highly polar aromatic compounds (5-25%)
- straight- and branched-chain alkanes (5-20%).

Bitumens contain low levels of 3-7 fused ring polycyclic aromatic hydrocarbons, but in the vacuum distillation process, most of these compounds appear in the distillate fractions.

Typically, bitumens boil above 450°C and have densities in the range 1.00 to 1.05 g/ml. They have negligible vapour pressures at ambient temperatures and have extremely low water solubilities.

3. Ecotoxicity data

3.1 Experimental data

There are no known acute or chronic ecotoxicity data for bitumens[3].

3.2 Predicted toxicity

The molecular weight range of bitumen components has been estimated as being in the range 500 to 15,000 and the predicted water solubilities of these substances are so low that no effects would be expected on aquatic organisms.

4. Bioaccumulation

Although all the constituents of bitumens have log K_{ow} values in excess of 6 and hence, are potentially bioaccumulative, in practice the very low water solubilities and high molecular weights of these substances is such that their bioavailability to aquatic organisms is very limited. Accordingly, the bioaccumulation of bitumen components is very unlikely.

5. Biodegradation

There are no known studies of the biodegradation of bitumen in aquatic systems. However, from hundreds of years of experience of their use in roadway and roofing applications, they are clearly persistent materials, the absence of biodegradation being a key property.

6. Environmental fate

Clearly, volatility is not a significant loss process for bitumens over the normal range of ambient temperatures encountered in EU countries. However, for road paving and roofing applications, bitumens are heated prior to application, causing fume to enter the atmosphere. Most of this fume rapidly condenses and the components fall out on to surfaces or soil where they are adsorbed; the more volatile hydrocarbon components will react with hydroxyl radicals in the atmosphere [4]. On release to water, bitumens tend to float or sink; they show little tendency to disperse and are persistent in this medium the main physical effect being adsorption to sediment. In soil, bitumens are both immobile and inert, adsorption again being the main physical process.

7. References

1. CONCAWE (1995) The classification and labelling of dangerous substances according to the EU dangerous substances directive. Report No. 95/59. Brussels: CONCAWE

2. IARC (1985) IARC Monographs on the evaluation of the carcinogenic risk of chemicals to humans, Volume 35: Polynuclear aromatic compounds, Part 4, Bitumens, coal-tars and derived products, shale-oils and soots, p. 39-81. Lyon: International Agency for Research on Cancer

3. CONCAWE (1992) Bitumens and bitumen derivatives. Product Dossier No. 92/104. Brussels: CONCAWE

4. Atkinson, R. (1990) Gas-phase tropospheric chemistry of organic compounds: a review. *Atmos Environ 24A, 1-41*

APPENDIX 22

PETROLEUM COKES

1. Description

Petroleum cokes are produced by the high temperature decomposition of heavy oil streams and consist predominantly of elemental carbon.

EINECS contains 3 entries for petroleum cokes.

For labelling purposes, the recommended short name for these substances is “petroleum coke”.

2. Composition / Properties

Petroleum cokes are elemental carbon in granular or needle-like form, and may contain small quantities of very high molecular weight hydrocarbons (typically with high carbon-to-hydrogen ratios) [1]. These substances have very low vapour pressures at ambient temperature and are extremely, insoluble in water.

3. Ecotoxicity

3.1 Experimental data

There are no known experimental ecotoxicity data for petroleum cokes.

3.2 Predicted Toxicity

Elemental carbon poses no risk to aquatic organisms, whilst the hydrocarbon concentrations of petroleum cokes are typically low and comprise very high molecular weight compounds. Such hydrocarbons are too water insoluble to cause acute aquatic toxicity, whilst their log K_{ow} values are well above the applicable range for acute toxicity QSARs. The application of chronic toxicity QSARs and the parabolic equation relating body burden to log K_{ow} recommended in the Technical Guidance Document [2], also indicate a lack of chronic aquatic toxicity.

4. Bioaccumulation

Elemental carbon is not known to bioaccumulate and there are no known data relating to the determination of BCF or log K_{ow} values for the hydrocarbon constituents of petroleum cokes. The very high molecular weight of these compounds, combined with their very low water solubilities, indicate that they are not likely to bioaccumulate.

5. Biodegradation

Clearly, elemental carbon and hence, petroleum coke is a persistent material. Also, any associated very high molecular weight hydrocarbons would only be very slowly biodegraded.

6. Environmental Fate

The hydrocarbon components of petroleum cokes have negligible vapour pressures at ambient temperature and hence volatility will not be a significant fate process for these substances.

On release into the environment, petroleum cokes will persist.

7. References

1. CONCAWE (1993) Petroleum coke. Product Dossier No. 93/105. Brussels: CONCAWE

2. EU (1996) Technical guidance document in support of Commission Directive 93/67/EEC on risk assessment for new notified substances and Commission Regulation (EC) 1488/94 on risk assessment for existing substances. Part IV, Chapter 4: Use of quantitative structure activity relationships (QSARs) in risk assessment. Luxembourg: Office for Official Publications of the European Communities

APPENDIX 23

OTHER PETROLEUM GASES

1. Description

The group referred to as Other Petroleum Gases comprises 55 substances entered in EINECS. They derive from the distillation of crude oil, or as by-products from other refinery operations. These products are not generally made available commercially, instead serving as feedstock and fuel streams within the refinery. Refinery gases differ from 'petroleum gases' (see **Appendix 2**) in that they may contain significant concentrations of non-hydrocarbon gases, such as hydrogen, nitrogen or hydrogen sulphide.

For labelling purposes, the short name "refinery gas" has been assigned to these substances.

2. Composition/properties

Refinery gases consist predominantly of C_1 to C_5 hydrocarbons, together with significant concentrations of other gases, such as hydrogen, nitrogen, carbon monoxide, hydrogen sulphide, etc.

As far as is known, there are no published analytical data for refinery gas streams. However, recorded physical property data for the major constituents are included in **Table 1**.

***Table 1*:** Physical properties of the major constituents of Refinery Gases

Component	Density (g/ml)	Boiling point (^oC)	Water solubility at 20(^oC) (mg/l)
Methane	0.466 (at -164^oC)	-161	24
Ethane	0.572 (at -100^oC)	-89	60
Propane	0.585 (at -45°C)	-42	65
n-Butane	0.578 (at 20°C)	-0.5	61
Isobutane	0.549 (at 30°C)	-12	49
Propylene	0.519 (at 20^oC)	-48	200
1-Butene	0.595 (at 20°C)	-6	222 (at 25°C)
Isobutene	0.604 (at 20^oC)	-7	263
1,3-Butadiene	0.621 (at 20°C)	-4.5	731
n-Pentane	0.626 (at 20°C)	35	39
Nitrogen	1.02 (at -252°C)	-196	29 (at 0^oC)
Hydrogen sulphide	1.54 (at 0^oC)	-62	4100

3. Ecotoxicity

3.1 Experimental data

There are no known aquatic toxicity data available for refinery gas streams or their principal hydrocarbon constituents. However, the data presented in **Table 1** show that the hydrocarbon constituents of refinery gases have relatively low solubilities and their boiling points are such that they will readily volatilise from water. Refinery gases would not be expected to have any significant ecotoxicological effect on aquatic organisms.

3.2 Predicted toxicity

As noted in **Appendix 2**, QSAR calculations of the acute aquatic toxicities for the C_3 to C_5 alkanes against fish, *Daphnia* and algal are in the range 1 to 21 mg/l. Although these hydrocarbons have individual water solubilities above these values, their extreme volatility is such that this toxicity is not exhibited in the aquatic environment.

Hydrogen sulphide (which may be present at concentrations up to 1% in particular gas streams) is soluble in water, and it is conceivable that under certain circumstances sufficient could dissolve to cause aquatic toxicity. Hydrogen sulphide is very toxic to aquatic organisms, with 96 hour LC_{50} values in shrimp species of the order of 0.1 to 0.4 mg/l [1]. There are some data to suggest that the toxicity of hydrogen sulphide may vary with pH (greater in more acidic waters), probably due to the degree of ionisation and with dissolved oxygen concentration, due to the oxidation of the sulphide [2]. Trace metal concentrations in the water will also effect toxicity, due to the rapid production of insoluble metal sulphides.

4. Biodegradation

As far as is known, no biodegradation studies have been conducted on refinery gases. Zobell [3] reports that 35-day BOD tests were run on methane and ethane at 25^{o}C using adapted micro-organisms and these resulted in 65.7 and 72.6% biodegradation respectively. These results indicate that these gases are inherently biodegradable.

In the real world, the hydrocarbon constituents of refinery gases do not remain in solution for a sufficient period for biodegradability to be a significant loss process.

Hydrogen sulphide, which may be present in some refinery gas streams, will be rapidly oxidised in water and insoluble sulphides are precipitated from water when metallic radicals are present.

5. Bioaccumulation

There are no known determinations of log K_{ow} or BCF values for refinery gases. Studies for propane, n-butane, 2-butene, 1-pentene and isobutane indicate that their log K_{ow} values are all in the range 1.85 to 2.8 [4,5]. Since these log K_{ow} values are below 3, the hydrocarbon constituents of refinery gases are not considered to be potentially bioaccumulative.

6. Environmental fate

Because of their extreme volatility, air is the principal environment compartment in which refinery gas components will be found. In air, the constituent hydrocarbons are photodegraded by reaction with hydroxyl radicals [6]; the half-lives of propane, isobutane and n-butane are 7, 3.4 and 3.2 days respectively.

If hydrogen sulphide is present, this will be rapidly oxidised in air and in water will rapidly react with dissolved metals to form insoluble metal sulphides.

7. References

1. Gopakumar, G. and Kuttyama, V.J. (1996) Effect of hydrogen sulphide on two species of Penaeid prawns *Penaeus indicus* (H. Milne Edwards) and *Metapenaeus dobsoni* (Miers). *Bull Environ Contam Toxicol 57, 824-828*

2. Brouwer, H. and Murphy, T. (1995) Volatile sulfides and their toxicity in freshwater sediments. *Environ Toxicol Chem 14, 2, 203-208*

3. ZoBell, C.E. (1963) The occurrence, effects, and fate of oil polluting the sea. *Int J Air Water Poll 7, 173-198*

4. Pomona College (1993) Log P_{ow} database. Claremont CA: Pomona College

5. Lyman, W.J. et al (1982) Handbook of chemical property estimation methods. New York: McGraw-Hill Book Co.

6. Atkinson, R. (1990) Gas-phase tropospheric chemistry of organic compounds: a review. *Atmos Environ 24A, 1-41*

APPENDIX 24

RECLAIM PETROLEUM SUBSTANCES

1. Description

This is a group of 12 substances which are either disposed of as waste, or are recycled to produce usable products.

The range of petroleum substances included within this group is very varied. Furthermore by their nature, many of the substances are of ill-defined or highly variable composition. The EINECS entries include low molecular weight hydrocarbon mixtures, slimes and sludges and high molecular weight hydrocarbon wastes.

For labelling purposes, the recommended short name for substances in this group is “refinery reclaim substance”.

2. Composition / Properties

There are no known data relating to the properties of substances in this group. Although the major constituents of substances in this group are hydrocarbons, their compositions will be highly variable.

3. Ecotoxicity

The aquatic toxicity of individual substances within this group will depend on the compositions of the products and general conclusions cannot be drawn for the group.

4. Bioaccumulation

The variable compositions of substances in this group are such that no general statement can be made about their bioaccumulation potential.

5. Biodegradation

There are no known biodegradation data for substances in this group. Further, because of their variable compositions, no general conclusions can be drawn on their potential to biodegrade.

6. Environmental Fate

From the definitions of substances in this group, their fate on release to the environment will vary from almost complete loss by volatilisation to persistence in water and soil from the presence of recalcitrant compounds. Accordingly, the environmental fate of substances in this group must be assessed on a case-by-case basis.

APPENDIX 25

OTHER PETROLEUM SUBSTANCES

1. Description

This is a group of 14 substances that could not readily be incorporated in any of the other groups because of their ill-defined nature or their broad range of compositions. The substances include low molecular weight hydrocarbon mixtures, middle distillates and residues.

For labelling purposes, the recommended short name for substances in this group is “petroleum substance – unspecified”.

2. Composition / Properties

There are no known data on the composition and properties of substances in this group, but it is evident from their definitions that these parameters will be highly variable.

3. Ecotoxicity

There are no known experimental ecotoxicity data for substances in this group.

The predicted aquatic toxicity of individual substances within this group is likely to be highly variable and no general conclusions can be drawn.

4. Bioaccumulation

The variable compositions of substances in this group are such that no general statement can be made about their potential for bioaccumulation.

5. Biodegradation

There are no known biodegradability data for substances in this group. Further, the variable nature of the compositions of these substances is such that no general conclusions can be drawn on their potential to biodegrade.

6. Environmental Fate

From the definitions of substances in this group, their fate on release to the environment will vary from almost complete loss by volatilisation to persistence in water and soil from the presence of recalcitrant compounds. Accordingly, the environmental fate of substances in this group must be assessed on a case-by-case basis.

ANNEX I

ENVIRONMENTAL HAZARD CRITERIA FOR SUBSTANCES

Extract from Directive 2001/59/EC (28th ATP of the Dangerous Substances Directive).

5. CLASSIFICATION ON THE BASIS OF ENVIRONMENTAL EFFECTS

5.1. **Introduction**

The primary objective of classifying substances and preparations dangerous for the environment is to alert the user to the hazards these substances and preparations present to ecosystems. Although the present criteria refer to aquatic ecosystems it is recognised that certain substances and preparations may simultaneously or alternatively affect other ecosystems whose constituents may range from soil microflora and microfauna to primates.

The criteria set out below follow directly from the test methods set out in Annex V in so far as they are mentioned. The test methods required for the 'base set' referred to in Annex VII are limited and the information derived from them may be insufficient for an appropriate classification. Classification may require additional data derived from level 1 (Annex VIII) or other equivalent studies. Furthermore, classified substances may be subject to review in the light of other new data.

For the purposes of classification and labelling and having regard to the current state of knowledge such substances and preparations are divided into two groups according to their acute and/or long-term effects in aquatic systems or their acute and/or long-term effects in non-aquatic systems.

5.1.1. The classification of substances is usually made on the basis of experimental data for acute aquatic toxicity, degradation, and log P_{ow} (or BCF if available).

5.1.2. The classification of preparations shall normally be carried out on the basis of a conventional method referred to in Article 7 of and Annex III, Parts A and B, to Directive 1999/45/EC. In this case, the classification is based on the individual concentration limits

— in Annex I to this Directive

— or in Annex III, Part B, to Directive 1999/45/EC where the substance or substances do not appear in Annex I to this Directive or appear in it without concentration limits.

5.1.3. Normally, the classification of a preparation is made on the basis of a conventional method. However, for the determination of the acute aquatic toxicity, there may be cases for which it is appropriate to carry out tests on the preparation. The result of these tests on the preparation may only modify the classification concerning acute aquatic toxicity which would have been obtained by the application of a conventional method. If such tests are chosen by the person responsible for the placing on the market, it must be ensured that the quality criteria of the test methods in Part C of Annex V to this Directive have been complied with. Furthermore, the tests are to be carried out on all three groups of species in conformity with the criteria in this Annex (algae, daphnia and fish), unless the highest hazard classification relating to acute aquatic toxicity has been assigned to the preparation after testing on one of the species or a test result was already available before Directive 1999/45/EC entered into force.

5.2. **Criteria for classification, indication of danger, choice of risk phrases**

The classification criteria for substances in section 5.2.1 only apply to preparations where they have been tested in accordance with 5.1.3.

5.2.1. Aquatic environment

5.2.1.1. Substances shall be classified as dangerous for the environment and assigned the symbol 'N' and the appropriate indication of danger, and assigned risk phrases in accordance with the following criteria:

R50 Very toxic to aquatic organisms, and

R53 May cause long-term adverse effects in the aquatic environment

Acute toxicity:		96 h LC_{50} (for fish)	≤ 1 mg/l
	or	48 h EC_{50} (for daphnia)	≤ 1 mg/l
	or	72 h IC_{50} (for algae)	≤ 1 mg/l

and:

— the substance is not readily degradable, or

— the log P_{ow} (log octanol/water partition coefficient) ≥ 3,0 (unless the experimentally determined BCF ≤ 100).

R50 Very toxic to aquatic organisms

Acute toxicity:		96 h LC_{50} (for fish)	≤ 1 mg/l
	or	48 h EC_{50} (for daphnia)	≤ 1 mg/l
	or	72 h IC_{50} (for algae)	≤ 1 mg/l

R51 Toxic to aquatic organisms, and

R53 May cause long-term adverse effects in the aquatic environment

Acute toxicity:		96 h LC_{50} (for fish)	1 mg/l < LC_{50} ≤ 10 mg/l
	or	48 h EC_{50} (for daphnia)	1 mg/l < EC_{50} ≤ 10 mg/l
	or	72 h IC_{50} (for algae)	1 mg/l < IC_{50} ≤ 10 mg/l

and:

— the substance is not readily degradable, or

— the log P_{ow} ≥ 3,0 (unless the experimentally determined BCF ≤ 100).

5.2.1.2. Substances shall be classified as dangerous for the environment in accordance with the criteria set out below. Risk phrases shall also be assigned in accordance with the following criteria

R52 Harmful to aquatic organisms, and

R53 May cause long-term adverse effects in the aquatic environment

Acute toxicity:		96 h LC_{50} (for fish)	10 mg/l < LC_{50} ≤ 100 mg/l
	or	48 h EC_{50} (for daphnia)	10 mg/l < EC_{50} ≤ 100 mg/l
	or	72 h IC_{50} (for algae)	10 mg/l < IC_{50} ≤ 100 mg/l

and:

the substance is not readily degradable.

This criterion applies unless there exists additional scientific evidence concerning degradation and/or toxicity sufficient to provide an adequate assurance that neither the substance nor its degradation products will constitute a potential long-term and/or delayed danger to the aquatic environment. Such additional scientific evidence should normally be based on the studies required at level 1 (Annex VIII), or studies of equivalent value, and could include:

(i) a proven potential to degrade rapidly in the aquatic environment;

(ii) an absence of chronic toxicity effects at a concentration of 1,0 mg/litre, e.g. a no-observed effect concentration of greater than 1,0 mg/litre determined in a prolonged toxicity study with fish or daphnia.

R52 Harmful to aquatic organisms

Substances not falling under the criteria listed above in this chapter, but which on the basis of the available evidence concerning their toxicity may nevertheless present a danger to the structure and/or functioning of aquatic ecosystems.

R53 May cause long-term adverse effects in the aquatic environment

Substances not falling under the criteria listed above in this chapter, but which, on the basis of the available evidence concerning their persistence, potential to accumulate, and predicted or observed environmental fate and behaviour may nevertheless present a long-term and/or delayed danger to the structure and/or functioning of aquatic ecosystems.

For example, poorly water-soluble substances, i.e. substances with a solubility of less than 1 mg/l will be covered by this criterion if:

(a) they are not readily degradable; and

(b) the log $P_{ow} \geq 3,0$ (unless the experimentally determined BCF ≤ 100).

This criterion applies to substances unless there exists additional scientific evidence concerning degradation and/or toxicity sufficient to provide an adequate assurance that neither the substance nor its degradation products will constitute a potential long-term and/or delayed danger to the aquatic environment.

Such additional scientific evidence should normally be based on the studies required at level 1 (Annex VIII), or studies of equivalent value, and could include

(i) a proven potential to degrade rapidly in the aquatic environment;

(ii) an absence of chronic toxicity effects at the solubility limit e.g. a no-observed effect concentration of greater than the solubility limit determined in a prolonged toxicity study with fish or daphnia.

5.2.1.3. *Comments on the determination of IC_{50} for algae and of degradability*

— where it can be demonstrated in the case of highly coloured substances that algal growth is inhibited solely as a result of a reduction in light intensity, then the 72h IC_{50} for algae should not be used as a basis for classification,

— substances are considered readily degradable if the following criteria hold true.

(a) if in 28-day biodegradation studies the following levels of degradation are achieved

— in tests based upon dissolved organic carbon: 70 %,

— in tests based upon oxygen depletion or carbon dioxide generation: 60 % of the theoretical maxima.

These levels of biodegradation must be achieved within 10 days of the start of degradation, which point is taken as the time when 10 % of the substance has been degraded; or

(b) if in those cases where only COD and BOD5 data are available when the ratio of BOD5/COD is greater than or equal to 0,5; or

(c) if other convincing scientific evidence is available to demonstrate that the substance can be degraded (biotically and/or abiotically) in the aquatic environment to a level of > 70 % within a 28-day period.

5.2.2. Non-aquatic environment

5.2.2.1. Substances and preparations shall be classified as dangerous for the environment and assigned the symbol 'N' and the appropriate indication of danger, and assigned risk phrases in accordance with the following criteria:

R54 Toxic to flora

R55 Toxic to fauna

R56 Toxic to soil organisms

R57 Toxic to bees

R58 May cause long-term adverse effects in the environment

Substances and preparations which on the basis of the available evidence concerning their toxicity, persistence, potential to accumulate and predicted or observed environmental fate and behaviour may present a danger, immediate or long-term and/or delayed, to the structure and/or functioning of natural ecosystems other than those covered under 5.2.1. Detailed criteria will be elaborated later.

5.2.2.2. Substances and preparations shall be classified as dangerous for the environment, and assigned the symbol 'N' and the appropriate indication of danger, where applicable, and assigned risk phrases in accordance with the following criteria:

R59 Dangerous for the ozone layer

Substances which on the basis of the available evidence concerning their properties and their predicted or observed environmental fate and behaviour may present a danger to the structure and/or the functioning of the stratospheric ozone layer. This includes the substances which are listed in Annex I to Council Regulation (EC) No 2037/2000 on substances that deplete the ozone layer (OJ L 244, 29.9.2000, p.1) and its subsequent amendments.

Preparations shall be classified on the basis of a conventional method referred to in Article 7 of and Annex III, Parts A and B, to Directive 1999/45/EC.

ANNEX II

LISTINGS OF PETROLEUM SUBSTANCES

IIA. Groups of Petroleum Substances (EINECS Number Order)

IIB. Petroleum Substances (EINECS Number Order) with Short Names

ANNEX IIA

Groups of Petroleum Substances (EINECS No. order)

CRUDE OIL **Short name: Crude oil**

EINECS	CAS No.	INDEX No.	SUBSTANCE
232-298-5	8002-05-9	649-049-00-5	Petroleum

PETROLEUM GASES **Short name: Petroleum gas**

EINECS	CAS No.	INDEX No.	SUBSTANCE
200-827-9	74-98-6	601-003-00-5	Propane, liquefied C3H8
203-448-7	106-97-8	601-004-00-0	Butane, pure C4H10
268-629-5	68131-75-9	649-177-00-1	Gases (petroleum), C3-4
269-617-2	68307-98-2	649-178-00-7	Tail gas (petroleum), catalytic cracked distillate and catalytic cracked naphtha fractionation absorber.
269-618-8	68307-99-3	649-179-00-2	Tail gas (petroleum), catalytic polymn. naphtha fractionation stabilizer
269-619-3	68308-00-9	649-180-00-8	Tail gas (petroleum), catalytic reformed naphtha fractionation stabilizer, hydrogen sulfide-free
269-620-9	68308-01-0	649-181-00-3	Tail gas (petroleum), cracked distillate hydrotreater stripper
269-623-5	68308-03-2	649-183-00-4	Tail gas (petroleum), gas oil catalytic cracking absorber
269-624-0	68308-04-3	649-184-00-X	Tail gas (petroleum), gas recovery plant
269-625-6	68308-05-4	649-185-00-5	Tail gas (petroleum), gas recovery plant deethanizer
269-626-1	68308-06-5	649-186-00-0	Tail gas (petroleum), hydrodesulfurized distillate and hydrodesulfurized naphtha fractionator, acid-free
269-627-7	68308-07-6	649-187-00-6	Tail gas (petroleum), hydrodesulfurized vacuum gas oil stripper, hydrogen sulfide-free
269-628-2	68308-08-7	649-210-00-X	Tail gas (petroleum), isomerized naphtha fractionation stabilizer
269-629-8	68308-09-8	649-188-00-1	Tail gas (petroleum), light straight-run naphtha stabilizer, hydrogen sulfide-free
269-630-3	68308-10-1	649-182-00-9	Tail gas (petroleum), straight-run distillate hydrodesulfurizer, hydrogen sulfide-free
269-631-9	68308-11-2	649-189-00-7	Tail gas (petroleum), propane-propylene alkylation feed prep deethanizer
269-632-4	68308-12-3	649-190-00-2	Tail gas (petroleum), vacuum gas oil hydrodesulfurizer, hydrogen sulfide-free
270-071-2	68409-99-4	649-191-00-8	Gases (petroleum), catalytic cracked overheads
270-651-5	68475-57-0	649-193-00-9	Alkanes, C1-2
270-652-0	68475-58-1	649-194-00-4	Alkanes, C2-3
270-653-6	68475-59-2	649-195-00-X	Alkanes, C3-4
270-654-1	68475-60-5	649-196-00-5	Alkanes, C4-5
270-667-2	68476-26-6	649-197-00-0	Fuel gases
270-670-9	68476-29-9	649-198-00-6	Fuel gases, crude oil distillates
270-681-9	68476-40-4	649-199-00-1	Hydrocarbons, C3-4
270-682-4	68476-42-6	649-200-00-5	Hydrocarbons, C4-5
270-689-2	68476-49-3	649-201-00-0	Hydrocarbons, C2-4, C3-rich
270-704-2	68476-85-7	649-202-00-6	Petroleum gases, liquefied
270-705-8	68476-86-8	649-203-00-1	Petroleum gases, liquefied, sweetened
270-724-1	68477-33-8	649-204-00-7	Gases (petroleum), C3-4, isobutane-rich

270-726-2	68477-35-0	649-205-00-2	Distillates (petroleum), C3-6, piperylene-rich
270-750-3	68477-69-0	649-206-00-3	Gases (petroleum), butane splitter overheads
270-751-9	68477-70-3	649-207-00-3	Gases (petroleum), C2-3
270-752-4	68477-71-4	649-208-00-9	Gases (petroleum), catalytic-cracked gas oil depropanizer bottoms, C4-rich acid-free
270-754-5	68477-72-5	649-209-00-4	Gases (petroleum), catalytic-cracked naphtha debutanizer bottoms, C3-5-rich
270-755-0	68477-73-6	649-062-00-6	Gases (petroleum), catalytic cracked naphtha depropanizer overhead, C3-rich acid-free
270-756-6	68477-74-7	649-063-00-1	Gases (petroleum), catalytic cracker
270-757-1	68477-75-8	649-064-00-7	Gases (petroleum), catalytic cracker, C1-5-rich
270-758-7	68477-76-9	649-065-00-2	Gases (petroleum), catalytic polymd. naphtha stabilizer overhead, C2-4-rich
270-760-8	68477-79-2	649-066-00-8	Gases (petroleum), catalytic reformer, C1-4-rich
270-765-5	68477-83-8	649-067-00-3	Gases (petroleum), C3-5 olefinic-paraffinic alkylation feed
270-767-6	68477-85-0	649-068-00-9	Gases (petroleum), C4-rich
270-768-1	68477-86-1	649-069-00-4	Gases (petroleum), deethanizer overheads
270-769-7	68477-87-2	649-070-00-X	Gases (petroleum), deisobutanizer tower overheads
270-772-3	68477-90-7	649-071-00-5	Gases (petroleum), depropanizer dry, propene-rich
270-773-9	68477-91-8	649-072-00-0	Gases (petroleum), depropanizer overheads
270-777-0	68477-94-1	649-073-00-6	Gases (petroleum), gas recovery plant depropanizer overheads
270-778-6	68477-95-2	649-074-00-1	Gases (petroleum), Girbatol unit feed
270-782-8	68477-99-6	649-075-00-7	Gases (petroleum), isomerized naphtha fractionator, C4-rich, hydrogen sulfide-free
270-802-5	68478-21-7	649-076-00-2	Tail gas (petroleum), catalytic cracked clarified oil and thermal cracked vacuum residue fractionation reflex drum
270-803-0	68478-22-8	649-077-00-8	Tail gas (petroleum), catalytic cracked naphtha stabilization absorber
270-804-6	68478-24-0	649-078-00-3	Tail gas (petroleum), catalytic cracker, catalytic reformer and hydrodesulfurizer combined fractionater
270-806-7	68478-26-2	649-079-00-9	Tail gas (petroleum), catalytic reformed naphtha fractionation stabilizer
270-813-5	68478-32-0	649-080-00-4	Tail gas (petroleum), saturate gas plant mixed stream, C4-rich
270-814-0	68478-33-1	649-081-00-X	Tail gas (petroleum), saturate gas recovery plant, C1-2-rich
270-815-6	68478-34-2	649-082-00-5	Tail gas (petroleum), vacuum residues thermal cracker
270-990-9	68512-91-4	649-083-00-0	Hydrocarbons, C3-4-rich, petroleum distillate
271-000-8	68513-15-5	649-084-00-6	Gases (petroleum), full-range straight-run naphtha dehexanizer off
271-001-3	68513-16-6	649-085-00-1	Gases (petroleum), hydrocracking depropanizer off, hydrocarbon-rich
271-002-9	68513-17-7	649-086-00-7	Gases (petroleum), light straight-run naphtha stabilizer off
271-010-2	68513-66-6	649-087-00-2	Residues (petroleum), alkylation splitter, C4-rich
271-032-2	68514-31-8	649-088-00-8	Hydrocarbons, C1-4
271-038-5	68514-36-3	649-089-00-3	Hydrocarbons, C1-4, sweetened
271-259-7	68527-16-2	649-090-00-9	Hydrocarbons, C1-3
271-261-8	68527-19-5	649-091-00-4	Hydrocarbons, C1-4, debutanizer fraction
271-624-0	68602-83-5	649-092-00-X	Gases (petroleum), C1-5, wet
271-734-9	68606-25-7	649-093-00-5	Hydrocarbons, C2-4
271-735-4	68606-26-8	649-094-00-0	Hydrocarbons, C3
271-737-5	68606-27-9	649-095-00-6	Gases (petroleum), alkylation feed
271-742-2	68606-34-8	649-096-00-1	Gases (petroleum), depropanizer bottoms fractionation off
272-183-7	68783-07-3	649-097-00-7	Gases (petroleum), refinery blend
272-203-4	68783-64-2	649-098-00-2	Gases (petroleum), catalytic cracking
272-205-5	68783-65-3	649-099-00-8	Gases (petroleum), C2-4, sweetened
272-871-7	68918-99-0	649-100-00-1	Gases (petroleum), crude oil fractionation off
272-872-2	68919-00-6	649-101-00-7	Gas (petroleum), dehexanizer off
272-878-5	68919-05-1	649-102-00-2	Gases (petroleum), light straight run gasoline fractionation stabilizer off
272-879-0	68919-06-2	649-103-00-8	Gases (petroleum), naphtha unifiner desulfurization stripper off
272-882-7	68919-09-5	649-104-00-3	Gases (petroleum), straight-run naphtha catalytic reforming off
272-883-2	68919-10-8	649-106-00-4	Gases (petroleum), straight-run stabilizer off
272-893-7	68919-20-0	649-105-00-9	Gases (petroleum), fluidized catalytic cracker splitter overheads
273-169-3	68952-76-1	649-107-00-X	Gases (petroleum), catalytic cracked naphtha debutanizer
273-170-9	68952-77-2	649-108-00-5	Tail gas (petroleum), catalytic cracked distillate and naphtha stabilizer
273-175-6	68952-81-8	649-109-00-0	Tail gas (petroleum), thermal-cracked distillate, gas oil and naphtha absorber
273-176-1	68952-82-9	649-110-00-6	Tail gas (petroleum), thermal cracked hydrocarbon fractionation stabilizer, petroleum coking
273-265-5	68955-28-2	649-111-00-1	Gases (petroleum), light steam-cracked, butadiene conc.
273-270-2	68955-34-0	649-112-00-7	Gases (petroleum), straight-run naphtha catalytic reformer stabilizer overhead

289-339-5	87741-01-3	649-113-00-2	Hydrocarbons, C4
292-456-4	90622-55-2	649-114-00-8	Alkanes, C1-4, C3-rich
295-404-9	92045-22-2	649-115-00-3	Gases (petroleum), steam-cracker C3-rich
295-405-4	92045-23-3	649-116-00-9	Hydrocarbons, C4, steam-cracker distillate
295-463-0	92045-80-2	649-117-00-4	Petroleum gases, liquefied, sweetened, C4 fraction
306-004-1	95465-89-7	649-118-00-X	Hydrocarbons, C4, 1,3-butadiene- and isobutene-free
307-769-4	97722-19-5	649-119-00-5	Raffinates (petroleum), steam-cracked C4 fraction cuprous ammonium acetate extn., C3-5 and C3-5 unsatd., butadiene-free

LOW BOILING POINT NAPHTHAS (GASOLINES) **Short name: Low boiling point naphtha**

EINECS	CAS No.	INDEX No.	SUBSTANCE
232-349-1	8006-61-9	649-261-00-8	Gasoline, natural
232-443-2	8030-30-6	649-262-00-3	Naphtha
232-453-7	8032-32-4	649-263-00-9	Ligroine
265-041-0	64741-41-9	649-264-00-4	Naphtha (petroleum), heavy straight-run
265-042-6	64741-42-0	649-265-00-X	Naphtha (petroleum), full-range straight-run
265-046-8	64741-46-4	649-266-00-5	Naphtha (petroleum), light straight-run
265-192-2	64742-89-8	649-267-00-0	Solvent naphtha (petroleum), light aliph.
270-077-5	68410-05-9	649-268-00-6	Distillates (petroleum), straight-run Light
271-025-4	68514-15-8	649-269-00-1	Gasoline, vapour-recovery
271-727-0	68606-11-1	649-270-00-7	Gasoline, straight-run, topping-plant
272-186-3	68783-12-0	649-271-00-2	Naphtha (petroleum), unsweetened
272-931-2	68921-08-4	649-272-00-8	Distillates (petroleum), light straight-run gasoline fractionation stabilizer overheads
309-945-6	101631-20-3	649-273-00-3	Naphtha (petroleum), heavy straight-run, arom.-contg.

LOW BOILING POINT NAPHTHAS (GASOLINES) **Short name: Low boiling point modified naphtha**

EINECS	CAS No.	INDEX No.	SUBSTANCE
265-066-7	64741-64-6	649-274-00-9	Naphtha (petroleum), full-range alkylate
265-067-2	64741-65-7	649-275-00-4	Naphtha (petroleum), heavy alkylate
265-068-8	64741-66-8	649-276-00-X	Naphtha (petroleum), light alkylate
265-073-5	64741-70-4	649-277-00-5	Naphtha (petroleum), isomerization
265-086-6	64741-84-0	649-278-00-0	Naphtha (petroleum), solvent-refined light
265-095-5	64741-92-0	649-279-00-6	Naphtha (petroleum), solvent-refined heavy
270-088-5	68410-71-9	649-280-00-1	Raffinates (petroleum), catalytic reformer ethylene glycol-water countercurrent exts.
270-349-3	68425-35-4	649-281-00-7	Raffinates (petroleum), reformer, Lurgi unit. sepd.
271-267-0	68527-27-5	649-282-00-2	Naphtha (petroleum), full-range alkylate, butane-contg.
295-315-5	91995-53-8	649-283-00-8	Distillates (petroleum), naphtha steam cracking-derived, solvent-refined light
295-430-0	92045-49-3	649-284-00-3	Naphtha (petroleum), C4-12 butane-alkylate, isooctane-rich
295-436-3	92045-55-1	649-285-00-9	Hydrocarbons, hydrotreated light naphtha distillates, solvent-refined
295-440-5	92045-58-4	649-286-00-4	Naphtha (petroleum), isomerization, C6-fraction
295-446-8	92045-64-2	649-287-00-X	Hydrocarbons, C6-7, naphtha-cracking, solvent-refined
309-871-4	101316-67-0	649-288-00-5	Hydrocarbons, C6-rich, hydrotreated light naphtha distillates, solvent-refined

LOW BOILING POINT NAPHTHAS (GASOLINES) **Short name: Low boiling point cat-cracked naphtha**

EINECS	CAS No.	INDEX No.	SUBSTANCE
265-055-7	64741-54-4	649-289-00-0	Naphtha (petroleum), heavy catalytic cracked
265-056-2	64741-55-5	649-290-00-6	Naphtha (petroleum), light catalytic cracked
270-686-6	68476-46-0	649-291-00-1	Hydrocarbons, C3-C11 catalytic cracker distillates
272-185-8	68783-09-5	649-292-00-7	Naphtha (petroleum), catalytic cracked light distd.
295-311-3	91995-50-5	649-293-00-2	Distillates (petroleum), naphtha steam cracking-derived, hydrotreated light arom.
295-431-6	92045-50-6	649-294-00-8	Naphtha (petroleum), heavy catalytic cracked, sweetened
295-441-0	92045-59-5	649-295-00-3	Naphtha (petroleum), light catalytic cracked sweetened
295-794-0	92128-94-4	649-296-00-9	Hydrocarbons, C8-12, catalytic-cracking, chem. neutralized
309-974-4	101794-97-2	649-297-00-4	Hydrocarbons, C8-12, catalytic cracker distillates
309-987-5	101896-28-0	649-298-00-X	Hydrocarbons, C8-12, catalytic cracking, chem. neutralized, sweetened

LOW BOILING POINT NAPHTHAS (GASOLINES) **Short name: Low boiling point cat-reformed naphtha**

EINECS	CAS No.	INDEX No.	SUBSTANCE
265-065-1	64741-63-5	649-299-00-5	Naphtha (petroleum), light catalytic reformed
265-070-9	64741-68-0	649-300-00-9	Naphtha (petroleum), heavy catalytic reformed
270-660-4	68475-79-6	649-301-00-4	Distillates (petroleum), catalytic reformed depentanizer
270-687-1	68476-47-1	649-302-00-X	Hydrocarbons, C2-6, C6-8 catalytic reformer
270-794-3	68478-15-9	649-303-00-5	Residues (petroleum), C6-8, catalytic reformer
270-993-5	68513-03-1	649-304-00-0	Naphtha (petroleum), light catalytic reformed, arom.-free
271-008-1	68513-63-3	649-305-00-6	Distillates (petroleum), catalytic reformed straight-run naphtha overheads
271-058-4	68514-79-4	649-306-00-1	Petroleum products, hydrofiner-powerformer reformates
272-895-8	68919-37-9	649-307-00-7	Naphtha (petroleum), full-range reformed
273-271-8	68955-35-1	649-308-00-2	Naphtha (petroleum), catalytic reformed
285-509-8	85116-58-1	649-309-00-8	Distillates (petroleum), catalytic reformed hydrotreated light, C8-12 arom.
295-279-0	91995-18-5	649-310-00-3	Aromatic hydrocarbons, C8, catalytic reforming-derived
297-401-8	93571-75-6	649-311-00-9	Aromatic hydrocarbons, C7-12, C8-rich
297-458-9	93572-29-3	649-312-00-4	Gasoline, C5-C11, high-octane stabilized reformed
297-465-7	93572-35-1	649-313-00-X	Hydrocarbons, C7-12 C>9-arom.-rich, reforming heavy fraction
297-466-2	93572-36-2	649-314-00-5	Hydrocarbons, C5-11, nonaroms.-rich, reforming light fraction

LOW BOILING POINT NAPHTHAS (GASOLINES) **Short name: Low boiling point thermally cracked naphtha**

EINECS	CAS No.	INDEX No.	SUBSTANCE
265-075-6	64741-74-8	649-316-00-6	Naphtha (petroleum), light thermal cracked
265-085-0	64741-83-9	649-317-00-1	Naphtha (petroleum), heavy thermal cracked
267-563-4	67891-79-6	649-318-00-7	Distillates (petroleum), heavy arom.
267-565-5	67891-80-9	649-319-00-2	Distillates (petroleum), light arom.
270-344-6	68425-29-6	649-320-00-8	Distillates (petroleum), naphtha-raffinate pyrolyzate-derived, gasoline-blending
270-658-3	68475-70-7	649-321-00-3	Aromatic hydrocarbons, C6-8, naphtha-raffinate pyrolyzate-derived
271-631-9	68603-00-9	649-322-00-9	Distillates (petroleum), thermal cracked naphtha and gas oil
271-632-4	68603-01-0	649-323-00-4	Distillates (petroleum), thermal cracked naphtha and gas oil, C5-dimer-contg.
271-634-5	68603-03-2	649-324-00-X	Distillates (petroleum), thermal cracked naphtha and gas oil, extractive
273-266-0	68955-29-3	649-325-00-5	Distillates (petroleum), light thermal cracked, debutanized arom.
295-447-3	92045-65-3	649-326-00-0	Naphtha (petroleum), light thermal cracked, sweetened

LOW BOILING POINT NAPHTHAS (GASOLINES) **Short name: Low boiling point hydrogen treated naphtha**

EINECS	CAS No.	INDEX No.	SUBSTANCE
265-150-3	64742-48-9	649-327-00-6	Naphtha (petroleum), hydrotreated heavy
265-151-9	64742-49-0	649-328-00-1	Naphtha (petroleum), hydrotreated light
265-178-6	64742-73-0	649-329-00-7	Naphtha (petroleum), hydrodesulfurized light
265-185-4	64742-82-1	649-330-00-2	Naphtha (petroleum), hydrodesulfurized heavy
270-092-7	68410-96-8	649-331-00-8	Distillates (petroleum), hydrotreated middle, intermediate boiling
270-093-2	68410-97-9	649-332-00-3	Distillates (petroleum), light distillate hydrotreating process, low-boiling
270-094-8	68410-98-0	649-333-00-9	Distillates (petroleum), hydrotreated heavy naphtha, deisohexanizer overheads
270-988-8	68512-78-7	649-334-00-4	Solvent naphtha (petroleum), light arom., hydrotreated
285-511-9	85116-60-5	649-335-00-X	Naphtha (petroleum), hydrodesulfurized thermal cracked light
285-512-4	85116-61-6	649-336-00-5	Naphtha (petroleum), hydrotreated light, cycloalkane-contg
295-432-1	92045-51-7	649-337-00-0	Naphtha (petroleum), heavy steam-cracked, hydrogenated
295-433-7	92045-52-8	649-338-00-6	Naphtha (petroleum), hydrodesulfurized full-range
295-438-4	92045-57-3	649-339-00-1	Naphtha (petroleum), hydrotreated light steam-cracked
295-443-1	92045-61-9	649-340-00-7	Hydrocarbons, C4-12, naphtha-cracking, hydrotreated
295-529-9	92062-15-2	649-341-00-2	Solvent naphtha (petroleum), hydrotreated light naphthenic
296-942-7	93165-55-0	649-342-00-8	Naphtha (petroleum), light steam-cracked, hydrogenated.
297-852-0	93763-33-8	649-343-00-3	Hydrocarbons, C6-11, hydrotreated, dearomatized.
297-853-6	93763-34-9	649-344-00-9	Hydrocarbons, C9-12, hydrotreated, dearomatized.

LOW BOILING POINT NAPHTHAS (GASOLINES) **Short name: Low boiling point naphtha – unspecified**

EINECS	CAS No.	INDEX No.	SUBSTANCE
232-489-3	8052-41-3	649-345-00-4	Stoddard solvent
265-047-3	64741-47-5	649-346-00-X	Natural gas condensates (petroleum)
265-048-9	64741-48-6	649-347-00-5	Natural gas (petroleum), raw liq. mix
265-071-4	64741-69-1	649-348-00-0	Naphtha (petroleum), light hydrocracked
265-079-8	64741-78-2	649-349-00-6	Naphtha (petroleum), heavy hydrocracked
265-089-2	64741-87-3	649-350-00-1	Naphtha (petroleum), sweetened
265-115-2	64742-15-0	649-351-00-7	Naphtha (petroleum), acid-treated
265-122-0	64742-22-9	649-352-00-2	Naphtha (petroleum), chemically neutralized heavy
265-123-6	64742-23-0	649-353-00-8	Naphtha (petroleum), chemically neutralized light
265-170-2	64742-66-1	649-354-00-3	Naphtha (petroleum), catalytic dewaxed
265-187-5	64742-83-2	649-355-00-9	Naphtha (petroleum), light steam-cracked
265-199-0	64742-95-6	649-356-00-4	Solvent naphtha (petroleum), light arom.
268-618-5	68131-49-7	649-357-00-X	Aromatic hydrocarbons, C6-10, acid-treated, neutralized
270-690-8	68476-50-6	649-401-00-8	Hydrocarbons, C>=5, C5-6-rich
270-695-5	68476-55-1	649-402-00-3	Hydrocarbons, C5-rich*
270-725-7	68477-34-9	649-358-00-5	Distillates (petroleum), C3-C5, 2-methyl-2-butene-rich
270-735-1	68477-50-9	649-359-00-0	Distillates (petroleum), polymd. steam-cracked petroleum distillates, C5-12 fraction
270-736-7	68477-53-2	649-360-00-6	Distillates (petroleum), steam-cracked, C5-12 fraction
270-738-8	68477-55-4	NONE	Distillates (petroleum), steam-cracked, C5-10 fraction-, mixed with light steam-cracked petroleum naphtha C5 fraction
270-741-4	68477-61-2	NONE	Extracts (petroleum), cold-acid, C4-6
270-771-8	68477-89-4	649-363-00-2	Distillates (petroleum), depentanizer overheads
270-791-7	68478-12-6	649-364-00-8	Residues (petroleum), butane splitter bottoms
270-795-9	68478-16-0	649-365-00-3	Residual oils (petroleum), deisobutanizer tower
270-991-4	68513-02-0	649-366-00-9	Naphtha (petroleum), full-range coker
271-138-9	68516-20-1	649-367-00-4	Naphtha (petroleum), steam-cracked middle arom.
271-262-3	68527-21-9	649-368-00-X	Naphtha (petroleum), clay-treated full-range straight-run
271-263-9	68527-22-0	649-369-00-5	Naphtha (petroleum), clay-treated light straight-run
271-264-4	68527-23-1	649-370-00-0	Naphtha (petroleum), light steam-cracked arom.
271-266-5	68527-26-4	649-371-00-6	Naphtha (petroleum), light steam-cracked, debenzenized
271-635-0	68603-08-7	649-372-00-1	Naphtha (petroleum), arom.-contg
271-726-5	68606-10-0	649-373-00-7	Gasoline, pyrolysis, debutanizer bottoms
272-206-0	68783-66-4	649-374-00-2	Naphtha (petroleum), light, sweetened
272-896-3	68919-39-1	649-375-00-8	Natural gas condensates
272-932-8	68921-09-5	649-376-00-3	Distillates (petroleum), naphtha unifiner stripper
285-510-3	85116-59-2	649-377-00-9	Naphtha (petroleum), catalytic reformed light, arom.-free fraction
289-220-8	86290-81-5	649-378-00-4	Gasoline
292-695-4	90989-39-2	NONE	Aromatic hydrocarbons, C8-10
292-698-0	90989-42-7	649-379-00-X	Aromatic hydrocarbons, C7-8, dealkylation products, distn. residues
295-298-4	91995-38-9	649-380-00-5	Hydrocarbons, C4-C6, depentanizer lights, arom. hydrotreater
295-302-4	91995-41-4	649-381-00-0	Distillates (petroleum), heat-soaked steam-cracked naphtha, C5-rich
295-331-2	91995-68-5	649-382-00-6	Extracts (petroleum), catalytic reformed light naphtha solvent
295-434-2	92045-53-9	649-383-00-1	Naphtha (petroleum), hydrodesulphurized light, dearomatized
295-442-6	92045-60-8	649-384-00-7	Naphtha (petroleum), light, C5-rich, sweetened
295-444-7	92045-62-0	649-385-00-2	Hydrocarbons, C8-11, naphtha-cracking, toluene cut
295-445-2	92045-63-1	649-386-00-8	Hydrocarbons, C4-11 naphtha-cracking, arom.-free
296-028-8	92201-97-3	649-387-00-3	Naphtha (petroleum), light heat-soaked, steam-cracked
296-903-4	93165-19-6	649-388-00-9	Distillates (petroleum), C6-rich
302-639-3	94114-03-1	649-389-00-4	Gasoline, pyrolysis, hydrogenated
305-750-5	95009-23-7	649-390-00-X	Distillates (petroleum), steam-cracked, C8-12 fraction, polymd., distn. lights
308-261-5	97926-43-7	649-391-00-5	Extracts (petroleum), heavy naphtha solvent, clay-treated
308-713-1	98219-46-6	649-392-00-0	Naphtha (petroleum), light steam-cracked, debenzenized, thermally treated
308-714-7	98219-47-7	649-393-00-6	Naphtha (petroleum), light steam-cracked, thermally treated
309-862-5	101316-56-7	649-394-00-1	Distillates (petroleum), C7-9, C8-rich, hydrodesulfurized dearomatized
309-870-9	101316-66-9	649-395-00-7	Hydrocarbons, C6-8, hydrogenated sorption-dearomatized, toluene raffination
309-879-8	101316-76-1	649-396-00-2	Naphtha (petroleum), hydrodesulfurized full-range coker
309-976-5	101795-01-1	649-397-00-8	Naphtha (petroleum), sweetened light

310-012-0	102110-14-5	649-398-00-3	Hydrocarbons, C3-6, C5-rich, steam-cracked naphtha
310-013-6	102110-15-6	649-399-00-9	Hydrocarbons, C5-rich, dicyclopentadiene-contg.
310-057-6	102110-55-4	649-400-00-2	Residues (petroleum), steam-cracked light, arom.

STRAIGHT RUN KEROSINES **Short name: Straight run kerosine**

EINECS	CAS No.	INDEX No.	SUBSTANCE
232-366-4	8008-20-6	649-404-00-4	Kerosine (petroleum)
265-191-7	64742-88-7	649-405-00-X	Solvent naphtha (petroleum), medium aliph.
265-200-4	64742-96-7	649-406-00-5	Solvent naphtha (petroleum), heavy aliph.
295-418-5	92045-37-9	649-407-00-0	Kerosine (petroleum), straight-run wide-cut

CRACKED KEROSINES **Short name: Cracked kerosine**

EINECS	CAS No.	INDEX No.	SUBSTANCE
265-194-3	64742-91-2	649-408-00-6	Distillates (petroleum), steam-cracked
270-728-3	68477-39-4	649-409-00-1	Distillates (petroleum), cracked stripped steam-cracked petroleum distillates, C8-10 fraction
270-729-9	68477-40-7	649-410-00-7	Distillates (petroleum), cracked stripped steam-cracked petroleum distillates, C10-12 fraction
270-737-2	68477-54-3	649-411-00-2	Distillates (petroleum), steam-cracked, C8-12 fraction
285-507-7	85116-55-8	649-412-00-8	Kerosine (petroleum), hydrodesulfurized thermal cracked
292-621-0	90640-98-5	649-413-00-3	Aromatic hydrocarbons, C>=10, steam-cracking, hydrotreated
292-637-8	90641-13-7	649-414-00-9	Naphtha (petroleum), steam-cracked, hydrotreated, C9-10-arom.-rich
309-866-7	101316-61-4	649-415-00-4	Distillates (petroleum), thermal-cracked, alkylarom. hydrocarbon-rich
309-881-9	101316-80-7	649-417-00-5	Solvent naphtha (petroleum), hydrocracked heavy arom.
309-938-8	101631-13-4	649-416-00-X	Distillates (petroleum), catalytic cracked heavy tar light
309-940-9	101631-15-6	649-418-00-0	Distillates (petroleum), steam-cracked heavy tar light

OTHER KEROSINES **Short name: Kerosine – unspecified**

EINECS	CAS No.	INDEX No.	SUBSTANCE
265-074-0	64741-73-7	649-419-00-6	Distillates (petroleum), alkylate
265-099-7	64741-98-6	649-420-00-1	Extracts (petroleum), heavy naphtha solvent
265-132-5	64742-31-0	649-421-00-7	Distillates (petroleum), chemically neutralized light
265-149-8	64742-47-8	649-422-00-2	Distillates (petroleum), hydrotreated light
265-184-9	64742-81-0	649-423-00-8	Kerosine (petroleum), hydrodesulfurized
265-198-5	64742-94-5	649-424-00-3	Solvent naphtha (petroleum), heavy arom.
269-778-9	68333-23-3	649-425-00-9	Naphtha (petroleum), heavy coker
285-508-2	85116-57-0	649-426-00-4	Naphtha (petroleum), catalytic reformed hydrodesulfurized heavy, arom. fraction
294-799-5	91770-15-9	649-427-00-X	Kerosine (petroleum), sweetened
295-416-4	92045-36-8	649-428-00-5	Kerosine (petroleum), solvent-refined sweetened
297-854-1	93763-35-0	649-429-00-0	Hydrocarbons, C9-16, hydrotreated, dearomatized
307-033-2	97488-94-3	649-430-00-6	Kerosine (petroleum), solvent-refined hydrodesulfurized
309-864-6	101316-58-9	649-431-00-1	Distillates (petroleum), hydrodesulfurized full-range middle coker
309-882-4	101316-81-8	649-432-00-7	Solvent naphtha (petroleum), hydrodesulfurized heavy arom.
309-884-5	101316-82-9	649-433-00-2	Solvent naphtha (petroleum), hydrodesulfurized medium
309-944-0	101631-19-0	649-434-00-8	Kerosine (petroleum), hydrotreated

STRAIGHT RUN GAS OILS **Short name: Straight run gas oil**

EINECS	CAS No.	INDEX No.	SUBSTANCE
265-043-1	64741-43-1	NONE	Gas oils (petroleum), straight-run
265-044-7	64741-44-2	NONE	Distillates (petroleum), straight-run middle
272-341-5	68814-87-9	NONE	Distillates (petroleum), full-range straight-run middle
272-817-2	68915-96-8	NONE	Distillates (petroleum), heavy straight-run
272-818-8	68915-97-9	NONE	Gas oils (petroleum), straight-run, high-boiling
294-454-9	91722-55-3	NONE	Distillates (petroleum), solvent-dewaxed straight-run middle
295-528-3	92062-14-1	NONE	Solvent naphtha (petroleum), heavy
296-468-0	92704-36-4	NONE	Gas oils (petroleum), straight-run, clay-treated
309-695-8	100684-24-0	NONE	Gas oils (petroleum), straight-run, carbon-treated

CRACKED GAS OILS (excluding hydrocracked gas oils) **Short name: Cracked gas oil**

EINECS	CAS No.	INDEX No.	SUBSTANCE
265-060-4	64741-59-9	649-435-00-3	Distillates (petroleum), light catalytic cracked
265-062-5	64741-60-2	649-436-00-9	Distillates (petroleum), intermediate catalytic cracked
265-084-5	64741-82-8	649-438-00-X	Distillates (petroleum), light thermal cracked
269-781-5	68333-25-5	649-439-00-5	Distillates (petroleum), hydrodesulfurized light catalytic cracked
270-662-5	68475-80-9	649-440-00-0	Distillates (petroleum), light steam-cracked naphtha
270-727-8	68477-38-3	649-441-00-6	Distillates (petroleum), cracked steam-cracked petroleum distillates
271-260-2	68527-18-4	649-442-00-1	Gas oils (petroleum), steam-cracked
285-505-6	85116-53-6	649-443-00-7	Distillates (petroleum), hydrodesulfurized thermal cracked middle
295-411-7	92045-29-9	649-444-00-2	Gas oils (petroleum), thermal-cracked, hydrodesulfurized
295-514-7	92062-00-5	649-445-00-8	Residues (petroleum), hydrogenated steam-cracked naphtha
295-517-3	92062-04-9	649-446-00-3	Residues (petroleum), steam-cracked naphtha distn.
295-991-1	92201-60-0	649-447-00-9	Distillates (petroleum), light catalytic cracked, thermally degraded
297-905-8	93763-85-0	649-448-00-4	Residues (petroleum), steam-cracked heat-soaked naphtha
308-278-8	97926-59-5	649-450-00-5	Gas oils (petroleum), light vacuum, thermal-cracked hydrodesulfurized
309-865-1	101316-59-0	649-451-00-0	Distillates (petroleum), hydrodesulfurized middle coker
309-939-3	101631-14-5	649-452-00-6	Distillates (petroleum), heavy steam-cracked

HYDROCRACKED GAS OILS **Short name: Cracked gas oil**

EINECS	CAS No.	INDEX No.	SUBSTANCE
265-078-2	64741-77-1	649-437-00-4	Distillates (petroleum), light hydrocracked
307-662-2	97675-88-2	649-449-00-X	Hydrocarbons, C16-20, solvent-dewaxed hydrocracked paraffinic distn. residue

VACUUM GAS OILS **Short name: Vacuum gas oil**

EINECS	CAS No.	INDEX No.	SUBSTANCE
265-049-4	64741-49-7	NONE	Condensates (petroleum), vacuum tower
265-059-9	64741-58-8	NONE	Gas oils (petroleum), light vacuum
265-190-1	64742-87-6	NONE	Gas oils (petroleum), hydrodesulfurized light vacuum
295-407-5	92045-24-4	NONE	Gas oils (petroleum), hydrotreated light vacuum
295-408-0	92045-26-6	NONE	Gas oils (petroleum), light vacuum, solvent-dewaxed
295-409-6	92045-27-7	NONE	Gas oils (petroleum), solvent-refined light vacuum
307-750-0	97722-01-5	NONE	Gas oil light naphthenic vacuum
307-754-2	97722-05-9	NONE	Hydrocarbons, C16-20, hydrotreated distillate, vacuum distn. lights
307-756-3	97722-07-1	NONE	Hydrocarbons, C11-17, naphthenic middle
309-693-7	100684-22-8	NONE	Gas oils (petroleum), light vacuum, carbon-treated
309-694-2	100684-23-9	NONE	Gas oils (petroleum), light vacuum, clay-treated

OTHER GAS OILS **Short name: Gas oil – unspecified**

EINECS	CAS No.	INDEX No.	SUBSTANCE
265-088-7	64741-86-2	649-212-00-0	Distillates (petroleum), sweetened middle
265-092-9	64741-90-8	649-213-00-6	Gas oils (petroleum), solvent-refined
265-093-4	64741-91-9	649-214-00-1	Distillates (petroleum), solvent-refined middle
265-112-6	64742-12-7	649-215-00-7	Gas oils (petroleum), acid-treated
265-113-1	64742-13-8	649-216-00-2	Distillates (petroleum), acid-treated middle
265-114-7	64742-14-9	649-217-00-8	Distillates (petroleum), acid-treated light
265-129-9	64742-29-6	649-218-00-3	Gas oils (petroleum), chemically neutralized
265-130-4	64742-30-9	649-219-00-9	Distillates (petroleum), chemically-neutralized middle
265-139-3	64742-38-7	649-220-00-4	Distillates (petroleum), clay-treated middle
265-148-2	64742-46-7	649-221-00-X	Distillates (petroleum), hydrotreated middle
265-182-8	64742-79-6	649-222-00-5	Gas oils (petroleum), hydrodesulfurized
265-183-3	64742-80-9	649-223-00-0	Distillates (petroleum), hydrodesulfurized middle
270-719-4	68477-29-2	649-228-00-8	Distillates (petroleum), catalytic reformer fractionator residue, high-boiling
270-721-5	68477-30-5	649-229-00-3	Distillates (petroleum), catalytic reformer fractionator residue, intermediate-boiling

270-722-0	68477-31-6	649-230-00-9	Distillates (petroleum), catalytic reformer fractionator residue, low-boiling
292-454-3	90622-53-0	649-242-00-4	Alkanes, C12-26-branched and linear
292-615-8	90640-93-0	649-231-00-4	Distillates (petroleum), highly refined middle
295-294-2	91995-34-5	649-232-00-X	Distillates (petroleum), catalytic reformer, heavy arom. conc.
300-227-8	93924-33-5	649-233-00-5	Gas oils, paraffinic
307-035-3	97488-96-5	649-234-00-0	Naphtha (petroleum), solvent-refined hydrodesulfurized heavy
307-659-6	97675-85-9	649-235-00-6	Hydrocarbons, C16-20, hydrotreated middle distillate, distn. lights
307-660-1	97675-86-0	649-236-00-1	Hydrocarbons, C12-20, hydrotreated paraffinic, distn. lights
307-757-9	97722-08-2	649-237-00-7	Hydrocarbons, C11-17, solvent-extd. light naphthenic
308-128-1	97862-78-7	649-238-00-2	Gas oils, hydrotreated
309-667-5	100683-97-4	649-239-00-8	Distillates (petroleum), carbon-treated light paraffinic
309-668-0	100683-98-5	649-240-00-3	Distillates (petroleum), intermediate paraffinic, carbon-treated
309-669-6	100683-99-6	649-241-00-9	Distillates (petroleum), intermediate paraffinic, clay-treated

OTHER GAS OILS – DISTILLATE FUEL OILS **Short name: Gas oil – unspecified**

EINECS	CAS No.	INDEX No.	SUBSTANCE
269-822-7	68334-30-5	649-224-00-6	Fuels, diesel
270-671-4	68476-30-2	649-225-00-2	Fuel oil, no. 2
270-673-5	68476-31-3	649-226-00-7	Fuel oil, no. 4
270-676-1	68476-34-6	649-227-00-2	Fuels, diesel, no. 2

HEAVY FUEL OIL COMPONENTS **Short name: Heavy fuel oil**

EINECS	CAS No.	INDEX No.	SUBSTANCE
265-045-2	64741-45-3	649-008-00-1	Residues (petroleum), atm. tower
265-058-3	64741-57-7	649-009-00-7	Gas oils (petroleum), heavy vacuum
265-063-0	64741-61-3	649-010-00-2	Distillates (petroleum), heavy catalytic cracked
265-064-6	64741-62-4	649-011-00-8	Clarified oils (petroleum), catalytic cracked
265-069-3	64741-67-9	649-048-00-X	Residues (petroleum), catalytic reformer fractionator
265-076-1	64741-75-9	649-012-00-3	Residues (petroleum), hydrocracked
265-081-9	64741-80-6	649-013-00-9	Residues (petroleum), thermal cracked
265-082-4	64741-81-7	649-014-00-4	Distillates (petroleum), heavy thermal cracked
265-162-9	64742-59-2	649-015-00-X	Gas oils (petroleum), hydrotreated vacuum
265-181-2	64742-78-5	649-016-00-5	Residues (petroleum), hydrodesulfurized atmospheric tower
265-189-6	64742-86-5	649-017-00-0	Gas oils (petroleum), hydrodesulfurized heavy vacuum
265-193-8	64742-90-1	649-018-00-6	Residues (petroleum), steam-cracked
269-777-3	68333-22-2	649-019-00-1	Residues (petroleum), atmospheric
269-782-0	68333-26-6	649-020-00-7	Clarified oils (petroleum), hydrodesulfurized catalytic cracked
269-783-6	68333-27-7	649-021-00-2	Distillates (petroleum), hydrodesulfurized intermediate catalytic cracked
269-784-1	68333-28-8	649-022-00-8	Distillates (petroleum), hydrodesulfurized heavy catalytic cracked
270-674-0	68476-32-4	649-023-00-3	Fuel oil, residues-straight-run gas oils, high-sulfur
270-675-6	68476-33-5	649-024-00-9	Fuel oil, residual
270-792-2	68478-13-7	649-025-00-4	Residues (petroleum), catalytic reformer fractionator residue distn.
270-796-4	68478-17-1	649-026-00-X	Residues (petroleum), heavy coker gas oil and vacuum gas oil
270-983-0	68512-61-8	649-027-00-5	Residues (petroleum), heavy coker and light vacuum
270-984-6	68512-62-9	649-028-00-0	Residues (petroleum), light vacuum
271-013-9	68513-69-9	649-029-00-6	Residues (petroleum), steam-cracked light
271-384-7	68553-00-4	649-030-00-1	Fuel oil, no. 6
271-763-7	68607-30-7	649-031-00-7	Residues (petroleum), topping plant, low-sulfur
272-184-2	68783-08-4	649-032-00-2	Gas oils (petroleum), heavy atmospheric
272-187-9	68783-13-1	649-033-00-8	Residues (petroleum), coker scrubber, condensed-ring-arom.-contg.
273-263-4	68955-27-1	649-034-00-3	Distillates (petroleum), petroleum residues vacuum
273-272-3	68955-36-2	649-035-00-9	Residues (petroleum), steam-cracked, resinous
274-683-0	70592-76-6	649-036-00-4	Distillates (petroleum), intermediate vacuum
274-684-6	70592-77-7	649-037-00-X	Distillates (petroleum), light vacuum
274-685-1	70592-78-8	649-038-00-5	Distillates (petroleum), vacuum
285-555-9	85117-03-9	649-039-00-0	Gas oils (petroleum), hydrodesulfurized coker heavy vacuum
292-657-7	90669-75-3	649-040-00-6	Residues (petroleum), steam-cracked, distillates
292-658-2	90669-76-4	649-041-00-1	Residues (petroleum), vacuum, light
295-396-7	92045-14-2	649-042-00-7	Fuel oil, heavy, high-sulfur
295-511-0	92061-97-7	649-043-00-2	Residues (petroleum), catalytic cracking

295-990-6	92201-59-7	649-044-00-8	Distillates (petroleum), intermediate catalytic cracked, thermally degraded
298-754-0	93821-66-0	649-045-00-3	Residual oils (petroleum)
308-733-0	98219-64-8	649-046-00-9	Residues, steam cracked, thermally treated
309-863-0	101316-57-8	649-047-00-4	Distillates (petroleum), hydrodesulfurized full-range middle

LUBRICATING GREASES **Short name: Grease**

EINECS	CAS No.	INDEX No.	SUBSTANCE
278-011-7	74869-21-9	649-243-00-X	Lubricating greases

UNREFINED/ACID TREATED OILS **Short name: Unrefined or mildly refined base oil**

EINECS	CAS No.	INDEX No.	SUBSTANCE
265-051-5	64741-50-0	649-050-00-0	Distillates (petroleum), light paraffinic
265-052-0	64741-51-1	649-051-00-6	Distillates (petroleum), heavy paraffinic
265-053-6	64741-52-2	649-052-00-1	Distillates (petroleum), light naphthenic
265-054-1	64741-53-3	649-053-00-7	Distillates (petroleum), heavy naphthenic
265-117-3	64742-18-3	649-054-00-2	Distillates (petroleum), acid-treated heavy naphthenic
265-118-9	64742-19-4	649-055-00-8	Distillates (petroleum), acid-treated light naphthenic
265-119-4	64742-20-7	649-056-00-3	Distillates (petroleum), acid-treated heavy paraffinic
265-121-5	64742-21-8	649-057-00-9	Distillates(petroleum), acid-treated light paraffinic
265-127-8	64742-27-4	649-058-00-4	Distillates (petroleum), chemically neutralized heavy paraffinic
265-128-3	64742-28-5	649-059-00-X	Distillates (petroleum), chemically neutralized light paraffinic
265-135-1	64742-34-3	649-060-00-5	Distillates (petroleum), chemically neutralized heavy naphthenic
265-136-7	64742-35-4	649-061-00-0	Distillates (petroleum), chemically neutralized light naphthenic

HIGHLY REFINED BASE OILS **Short name: Highly refined base oil**

EINECS	CAS No.	INDEX No.	SUBSTANCE
232-455-8	8042-47-5	NONE	White mineral oil (petroleum)
276-735-8	72623-83-7	NONE	Lubricating oils (petroleum), C>25, hydrotreated bright stock-based
295-425-3	92045-44-8	NONE	Lubricating oils (petroleum), hydrotreated bright stock-based
295-426-9	92045-45-9	NONE	Lubricating oils (petroleum), hydrotreated solvent-refined bright stock-based
295-550-3	92062-35-6	NONE	White mineral oil (petroleum), light

OTHER LUBRICANT BASE OILS **Short name: Base oil – unspecified**

EINECS	CAS No.	INDEX No.	SUBSTANCE
265-077-7	64741-76-0	649-453-00-1	Distillates (petroleum), heavy hydrocracked
265-090-8	64741-88-4	649-454-00-7	Distillates (petroleum), solvent-refined heavy paraffinic
265-091-3	64741-89-5	649-455-00-2	Distillates (petroleum), solvent-refined light paraffinic
265-096-0	64741-95-3	649-456-00-8	Residual oils (petroleum), solvent deasphalted
265-097-6	64741-96-4	649-457-00-3	Distillates (petroleum), solvent-refined heavy naphthenic
265-098-1	64741-97-5	649-458-00-9	Distillates (petroleum), solvent-refined light naphthenic
265-101-6	64742-01-4	649-459-00-4	Residual oils (petroleum), solvent-refined
265-137-2	64742-36-5	649-460-00-X	Distillates (petroleum), clay-treated heavy paraffinic
265-138-8	64742-37-6	649-461-00-5	Distillates (petroleum), clay-treated light paraffinic
265-143-5	64742-41-2	649-462-00-0	Residual oils (petroleum), clay-treated
265-146-1	64742-44-5	649-463-00-6	Distillates (petroleum), clay-treated heavy naphthenic
265-147-7	64742-45-6	649-464-00-1	Distillates (petroleum), clay-treated light naphthenic
265-155-0	64742-52-5	649-465-00-7	Distillates (petroleum), hydrotreated heavy naphthenic
265-156-6	64742-53-6	649-466-00-2	Distillates (petroleum), hydrotreated light naphthenic
265-157-1	64742-54-7	649-467-00-8	Distillates (petroleum), hydrotreated heavy paraffinic
265-158-7	64742-55-8	649-468-00-3	Distillates (petroleum), hydrotreated light paraffinic
265-159-2	64742-56-9	649-469-00-9	Distillates (petroleum), solvent-dewaxed light paraffinic
265-160-8	64742-57-0	649-470-00-4	Residual oils (petroleum), hydrotreated
265-166-0	64742-62-7	649-471-00-X	Residual oils (petroleum), solvent-dewaxed
265-167-6	64742-63-8	649-472-00-5	Distillates (petroleum), solvent-dewaxed heavy naphthenic
265-168-1	64742-64-9	649-473-00-0	Distillates (petroleum), solvent-dewaxed light naphthenic
265-169-7	64742-65-0	649-474-00-6	Distillates (petroleum), solvent-dewaxed heavy paraffinic
265-172-3	64742-68-3	649-475-00-1	Naphthenic oils (petroleum), catalytic dewaxed heavy

265-173-9	64742-69-4	649-476-00-7	Naphthenic oils (petroleum), catalytic dewaxed light
265-174-4	64742-70-7	649-477-00-2	Paraffin oils (petroleum), catalytic dewaxed heavy
265-176-5	64742-71-8	649-478-00-8	Paraffin oils (petroleum), catalytic dewaxed light
265-179-1	64742-75-2	649-479-00-3	Naphthenic oils (petroleum), complex dewaxed heavy
265-180-7	64742-76-3	649-480-00-9	Naphthenic oils (petroleum), complex dewaxed light
276-736-3	72623-85-9	649-481-00-4	Lubricating oils (petroleum), C20-50, hydrotreated neutral oil-based, high-viscosity
276-737-9	72623-86-0	649-482-00-X	Lubricating oils (petroleum), C15-30, hydrotreated neutral oil-based
276-738-4	72623-87-1	649-483-00-5	Lubricating oils (petroleum), C20-50, hydrotreated neutral oil-based
278-012-2	74869-22-0	649-484-00-0	Lubricating oils
292-613-7	90640-91-8	649-485-00-6	Distillates (petroleum), complex dewaxed heavy paraffinic
292-614-2	90640-92-9	649-486-00-1	Distillates (petroleum), complex dewaxed light paraffinic
292-616-3	90640-94-1	649-487-00-7	Distillates (petroleum), solvent dewaxed heavy paraffinic, clay-treated
292-617-9	90640-95-2	649-488-00-2	Hydrocarbons, C20-50, solvent dewaxed heavy paraffinic, hydrotreated
292-618-4	90640-96-3	649-489-00-8	Distillates (petroleum), solvent dewaxed light paraffinic, clay-treated
292-620-5	90640-97-4	649-490-00-3	Distillates (petroleum), solvent dewaxed light paraffinic, hydrotreated
292-656-1	90669-74-2	649-491-00-9	Residual oils (petroleum), hydrotreated solvent dewaxed
294-843-3	91770-57-9	649-492-00-4	Residual oils (petroleum), catalytic dewaxed
295-300-3	91995-39-0	649-493-00-X	Distillates (petroleum), dewaxed heavy paraffinic, hydrotreated
295-301-9	91995-40-3	649-494-00-5	Distillates (petroleum), dewaxed light paraffinic, hydrotreated
295-306-6	91995-45-8	649-495-00-0	Distillates (petroleum), hydrocracked solvent-refined, dewaxed
295-316-0	91995-54-9	649-496-00-6	Distillates (petroleum), solvent-refined light naphthenic, hydrotreated
295-423-2	92045-42-6	649-497-00-1	Lubricating oils (petroleum), C17-35, solvent-extd., dewaxed, hydrotreated
295-424-8	92045-43-7	649-498-00-7	Lubricating oils (petroleum), hydrocracked nonarom. solvent-deparaffined
295-499-7	92061-86-4	649-499-00-2	Residual oils (petroleum), hydrocracked acid-treated solvent-dewaxed
295-810-6	92129-09-4	649-500-00-6	Paraffin oils (petroleum), solvent-refined dewaxed heavy
297-474-6	93572-43-1	649-501-00-1	Lubricating oils (petroleum), base oils, paraffinic
297-857-8	93763-38-3	649-502-00-7	Hydrocarbons, hydrocracked paraffinic distn. residues, solvent-dewaxed
300-257-1	93924-61-9	649-503-00-2	Hydrocarbons, C20-50, residual oil hydrogenation vacuum distillate
305-588-5	94733-08-1	649-504-00-8	Distillates (petroleum), solvent-refined hydrotreated heavy, hydrogenated
305-589-0	94733-09-2	649-505-00-3	Distillates (petroleum), solvent-refined hydrocracked light
305-594-8	94733-15-0	649-506-00-9	Lubricating oils (petroleum), C18-40, solvent-dewaxed hydrocracked distillate-based
305-595-3	94733-16-1	649-507-00-4	Lubricating oils (petroleum), C18-40, solvent-dewaxed hydrogenated raffinate-based
305-971-7	95371-04-3	649-508-00-X	Hydrocarbons, C13-30, arom.-rich, solvent-extd. naphthenic distillate
305-972-2	95371-05-4	649-509-00-5	Hydrocarbons, C16-32, arom. rich, solvent-extd. naphthenic distillate
305-974-3	95371-07-6	649-510-00-0	Hydrocarbons, C37-68, dewaxed deasphalted hydrotreated vacuum distn. residues
305-975-9	95371-08-7	649-511-00-6	Hydrocarbons, C37-65, hydrotreated deasphalted vacuum distn. residues
307-010-7	97488-73-8	649-512-00-1	Distillates (petroleum), hydrocracked solvent-refined light
307-011-2	97488-74-9	649-513-00-7	Distillates (petroleum), solvent-refined hydrogenated heavy
307-034-8	97488-95-4	649-514-00-2	Lubricating oils (petroleum), C18-27, hydrocracked solvent-dewaxed
307-661-7	97675-87-1	649-515-00-8	Hydrocarbons, C17-30, hydrotreated solvent-deasphalted atm. distn. residue, distn. lights
307-755-8	97722-06-0	649-516-00-3	Hydrocarbons, C17-40, hydrotreated solvent-deasphalted distn. residue, vacuum distn. lights
307-758-4	97722-09-3	649-517-00-9	Hydrocarbons, C13-27, solvent-extd. light naphthenic
307-760-5	97722-10-6	649-518-00-4	Hydrocarbons, C14-29, solvent-extd. light naphthenic
308-131-8	97862-81-2	649-519-00-X	Hydrocarbons, C27-42, dearomatized
308-132-3	97862-82-3	649-520-00-5	Hydrocarbons, C17-30, hydrotreated distillates, distn. lights
308-133-9	97862-83-4	649-521-00-0	Hydrocarbons, C27-45, naphthenic vacuum distn.
308-287-7	97926-68-6	649-522-00-6	Hydrocarbons, C27-45, dearomatized
308-289-8	97926-70-0	649-523-00-1	Hydrocarbons, C20-58, hydrotreated
308-290-3	97926-71-1	649-524-00-7	Hydrocarbons, C27-42, naphthenic
309-710-8	100684-37-5	649-525-00-2	Residual oils (petroleum), carbon-treated solvent-dewaxed
309-711-3	100684-38-6	649-526-00-8	Residual oils (petroleum), clay-treated solvent-dewaxed
309-874-0	101316-69-2	649-527-00-3	Lubricating oils (petroleum), C>25, solvent-extd., deasphalted, dewaxed, hydrogenated

309-875-6	101316-70-5	649-528-00-9	Lubricating oils (petroleum), C17-32, solvent-extd., dewaxed, hydrogenated
309-876-1	101316-71-6	649-529-00-4	Lubricating oils (petroleum), C20-35, solvent-extd., dewaxed, hydrogenated
309-877-7	101316-72-7	649-530-00-X	Lubricating oils (petroleum), C24-50, solvent-extd., dewaxed, hydrogenated

RESIDUAL AROMATIC EXTRACTS **Short name: Residual aromatic extract**

EINECS	CAS No.	INDEX No.	SUBSTANCE
265-110-5	64742-10-5	NONE	Extracts (petroleum), residual oil solvent
295-332-8	91995-70-9	NONE	Extracts (petroleum), deasphalted vacuum residue solvent

UNTREATED DISTILLATE AROMATIC EXTRACTS **Short name: Distillate aromatic extract**

EINECS	CAS No.	INDEX No.	SUBSTANCE
265-102-1	64742-03-6	649-001-00-3	Extracts (petroleum), light naphthenic distillate solvent
265-103-7	64742-04-7	649-002-00-9	Extracts (petroleum), heavy paraffinic distillate solvent
265-104-2	64742-05-8	649-003-00-4	Extracts (petroleum), light paraffinic distillate solvent
265-111-0	64742-11-6	649-004-00-X	Extracts (petroleum), heavy naphthenic distillate solvent
295-341-7	91995-78-7	649-005-00-5	Extracts (petroleum), light vacuum gas oil solvent.
307-753-7	97722-04-8	649-006-00-0	Hydrocarbons, C26-55, arom. rich

TREATED DISTILLATE AROMATIC EXTRACTS **Short name: Distillate aromatic extract (treated)**

EINECS	CAS No.	INDEX No.	SUBSTANCE
272-175-3	68783-00-6	649-531-00-5	Extracts (petroleum), heavy naphthenic distillate solvent, arom. conc.
272-180-0	68783-04-0	649-532-00-0	Extracts (petroleum), solvent refined heavy paraffinic distillate solvent
272-342-0	68814-89-1	649-533-00-6	Extracts (petroleum), heavy paraffinic distillates, solvent deasphalted
292-631-5	90641-07-9	649-534-00-1	Extracts (petroleum), heavy naphthenic distillate solvent, hydrotreated
292-632-0	90641-08-0	649-535-00-7	Extracts (petroleum), heavy paraffinic distillate solvent, hydrotreated
292-633-6	90641-09-1	649-536-00-2	Extracts (petroleum), light paraffinic distillate solvent, hydrotreated
295-335-4	91995-73-2	649-537-00-8	Extracts (petroleum), hydrotreated light paraffinic distillate solvent
295-338-0	91995-75-4	649-538-00-3	Extracts (petroleum), light naphthenic distillate solvent, hydrodesulfurized
295-339-6	91995-76-5	649-539-00-9	Extracts (petroleum), light paraffinic distillate solvent, acid treated
295-340-1	91995-77-6	649-540-00-4	Extracts (petroleum), light paraffinic distillate solvent, hydrodesulfurized
295-342-2	91995-79-8	649-541-00-X	Extracts (petroleum), light vacuum gas oil solvent, hydrotreated
296-437-1	92704-08-0	649-542-00-5	Extracts (petroleum), heavy paraffinic distillate solvent, clay-treated
297-827-4	93763-10-1	649-543-00-0	Extracts (petroleum), heavy naphthenic distillate solvent, hydrodesulfurized
297-829-5	93763-11-2	649-544-00-6	Extracts (petroleum), solvent-dewaxed heavy paraffinic distillate
309-672-2	100684-02-4	649-545-00-1	Extracts (petroleum), light paraffinic distillate solvent, carbon-treated
309-673-8	100684-03-5	649-546-00-7	Extracts (petroleum), light paraffinic distillate solvent, clay-treated
309-674-3	100684-04-6	649-547-00-2	Extracts (petroleum), light vacuum, gas oil solvent, carbon-treated
309-675-9	100684-05-7	649-548-00-8	Extracts (petroleum), light vacuum gas oil solvent, clay-treated

OTHER AROMATIC EXTRACTS **Short name: Aromatic extract – unspecified**

EINECS	CAS No.	INDEX No.	SUBSTANCE
265-105-8	64742-06-9	NONE	Extracts (petroleum), middle distillate solvent
265-211-4	64743-06-2	NONE	Extracts (petroleum), gas oil solvent
272-173-2	68782-98-9	NONE	Extracts (petroleum), clarified oil solvent, condensed-ring arom.-contg.
272-174-8	68782-99-0	NONE	Extracts (petroleum), heavy clarified oil solvent, condensed-ring arom. contg.
272-177-4	68783-02-8	NONE	Extracts (petroleum), intermediate clarified oil solvent, condensed ring arom. contg.

272-179-5	68783-03-9	NONE	Extracts (petroleum), light clarified oil solvent, condensed-ring arom. contg.
295-330-7	91995-67-4	NONE	Extracts (petroleum), C15-30-arom., hydrotreated
295-333-3	91995-71-0	NONE	Extracts (petroleum), gas oil solvent, chem. neutralized
295-334-9	91995-72-1	NONE	Extracts (petroleum), gas oil solvent, hydrotreated
305-590-6	94733-10-5	NONE	Extracts (petroleum), hydrocracked residual oil solvent
307-012-8	97488-75-0	NONE	Extracts (petroleum), hydrocracked heavy solvent
309-670-1	100684-00-2	NONE	Extracts (petroleum), carbon-treated gas oil solvent
309-671-7	100684-01-3	NONE	Extracts (petroleum), clay-treated gas oil solvent
309-676-4	100684-06-8	NONE	Extracts (petroleum), middle distillate solvent, carbon-treated
309-678-5	100684-07-9	NONE	Extracts (petroleum), middle distillate solvent, clay-treated

PARAFFIN AND HYDROCARBON WAXES **Short name: Petroleum wax**

EINECS	CAS No.	INDEX No.	SUBSTANCE
232-315-6	8002-74-2	NONE	Paraffin waxes and Hydrocarbon waxes
264-038-1	63231-60-7	NONE	Paraffin waxes and hydrocarbon waxes, microcryst.
265-126-2	64742-26-3	NONE	Hydrocarbon waxes (petroleum), acid-treated
265-134-6	64742-33-2	NONE	Hydrocarbon waxes (petroleum), chemically neutralized
265-144-0	64742-42-3	NONE	Hydrocarbon waxes (petroleum), clay-treated microcryst.
265-145-6	64742-43-4	NONE	Paraffin waxes (petroleum), clay-treated
265-154-5	64742-51-4	NONE	Paraffin waxes (petroleum), hydrotreated
265-163-4	64742-60-5	NONE	Hydrocarbon waxes (petroleum), hydrotreated microcryst.
285-095-9	85029-72-7	NONE	Hydrocarbon waxes (petroleum), deodorized
292-640-4	90669-47-9	NONE	Paraffin waxes (petroleum), acid-treated
295-456-2	92045-74-4	NONE	Paraffin waxes (petroleum), low-melting
295-457-8	92045-75-5	NONE	Paraffin waxes (petroleum), low-melting, hydrotreated
295-458-3	92045-76-6	NONE	Paraffin waxes and Hydrocarbon waxes, microcryst, hydrotreated
307-045-8	97489-05-9	NONE	Paraffin waxes and Hydrocarbon waxes, C19-38
308-140-7	97862-89-0	NONE	Paraffin waxes (petroleum), carbon-treated
308-141-2	97862-90-3	NONE	Paraffin waxes (petroleum), low-melting, carbon-treated
308-142-8	97862-91-4	NONE	Paraffin waxes (petroleum), low-melting, clay-treated
308-143-3	97862-92-5	NONE	Paraffin waxes (petroleum), low-melting, silicic acid-treated
08-144-9	97862-93-6	NONE	Paraffin waxes (petroleum), silicic acid-treated
308-145-4	97862-94-7	NONE	Paraffin waxes and Hydrocarbon waxes, microcryst, carbon-treated
308-147-5	97862-95-8	NONE	Paraffin waxes and Hydrocarbon waxes, microcryst, clay-treated
308-148-0	97862-96-9	NONE	Paraffin waxes and Hydrocarbon waxes, microcryst, silicic acid-treated

FOOTS OILS **Short name: Foots oil**

EINECS	CAS No.	INDEX No.	SUBSTANCE
265-171-8	64742-67-2	649-549-00-3	Foots oil (petroleum)
295-394-6	92045-12-0	649-550-00-9	Foots oil (petroleum), hydrotreated
300-225-7	93924-31-3	649-175-00-0	Foots oil (petroleum), acid-treated
300-226-2	93924-32-4	649-176-00-6	Foots oil (petroleum), clay-treated
308-126-0	97862-76-5	649-211-00-5	Foots oil (petroleum), carbon-treated
308-127-6	97862-77-6	649-315-00-0	Foots oil (petroleum), silicic acid-treated

SLACK WAXES **Short name: Slack wax**

EINECS	CAS No.	INDEX No.	SUBSTANCE
265-165-5	64742-61-6	649-244-00-5	Slack wax (petroleum)
292-659-8	90669-77-5	649-245-00-0	Slack wax (petroleum), acid-treated
292-660-3	90669-78-6	649-246-00-6	Slack wax (petroleum), clay-treated
295-523-6	92062-09-4	649-247-00-1	Slack wax (petroleum), hydrotreated
295-524-1	92062-10-7	649-248-00-7	Slack wax (petroleum), low-melting
295-525-7	92062-11-8	649-249-00-2	Slack wax (petroleum), low-melting, hydrotreated
308-155-9	97863-04-2	649-250-00-8	Slack wax (petroleum), low-melting, carbon-treated
308-156-4	97863-05-3	649-251-00-3	Slack wax (petroleum), low-melting, clay-treated
308-158-5	97863-06-4	649-252-00-9	Slack wax (petroleum), low-melting, silicic acid-treated
309-723-9	100684-49-9	649-253-00-4	Slack wax (petroleum), carbon-treated

PETROLATUMS **Short name: Petrolatum**

EINECS	CAS No.	INDEX No.	SUBSTANCE
232-373-2	8009-03-8	649-254-00-X	Petrolatum
265-206-7	64743-01-7	649-255-00-5	Petrolatum (petroleum), oxidized
285-098-5	85029-74-9	649-256-00-0	Petrolatum (petroleum), alumina-treated
295-459-9	92045-77-7	649-257-00-6	Petrolatum (petroleum), hydrotreated
308-149-6	97862-97-0	649-258-00-1	Petrolatum (petroleum), carbon-treated
308-150-1	97862-98-1	649-259-00-7	Petrolatum (petroleum), silicic acid-treated
309-706-6	100684-33-1	649-260-00-2	Petrolatum (petroleum), clay-treated

USED AND RE-REFINED OILS **Short name: Used or re-refined oil**

EINECS	CAS No.	INDEX No.	SUBSTANCE
265-125-7	64742-25-2	NONE	Lubricating oils (petroleum), acid-treated, spent
265-133-0	64742-32-1	NONE	Lubricating oils (petroleum), chemically neutralized spent
265-152-4	64742-50-3	NONE	Lubricating oils (petroleum), clay-treated spent
265-161-3	64742-58-1	NONE	Lubricating oils (petroleum), hydrotreated spent
270-697-6	68476-77-7	NONE	Lubricating oils, refined used
274-635-9	70514-12-4	NONE	Lubricating oils, used
293-258-0	91052-94-7	NONE	Hydrocarbon oils, clay-treated spent
295-421-1	92045-40-4	NONE	Lubricating oils, used, distd.
295-422-7	92045-41-5	NONE	Lubricating oils, used, vacuum distd.
295-516-8	92062-03-8	NONE	Lubricating oils (petroleum), solvent-refined dist. used
297-104-3	93334-30-6	NONE	Lubricating oils, refined used, arom.-contg.
308-935-9	99035-68-4	NONE	Distillates (petroleum), C10-50, used, refined
309-878-2	101316-73-8	NONE	Lubricating oils (petroleum), used, noncatalytically refined

BITUMEN **Short name: Bitumen or vacuum residue**

EINECS	CAS No.	INDEX No.	SUBSTANCE
232-490-9	8052-42-4	NONE	Asphalt
265-057-8	64741-56-6	NONE	Residues (petroleum), vacuum
265-188-0	64742-85-4	NONE	Residues (petroleum), hydrodesulfurized vacuum
265-196-4	64742-93-4	NONE	Asphalt, oxidized
295-284-8	91995-23-2	NONE	Asphaltenes (petroleum)
295-518-9	92062-05-0	NONE	Residues (petroleum), thermal cracked vacuum
302-656-6	94114-22-4	NONE	Residues (petroleum), dewaxed heavy parafinnic, vacuum
309-712-9	100684-39-7	NONE	Residues (petroleum), distn. residue hydrogenation
309-713-4	100684-40-0	NONE	Residues (petroleum), vacuum distn. residue hydrogenation

PETROLEUM COKE **Short name: Petroleum coke**

EINECS	CAS No.	INDEX No.	SUBSTANCE
265-080-3	64741-79-3	NONE	Coke (petroleum)
265-209-3	64743-04-0	NONE	Coke (petroleum), recovery
265-210-9	64743-05-1	NONE	Coke (petroleum), calcined

OTHER PETROLEUM GASES **Short name: Refinery gas**

EINECS	CAS No.	INDEX No.	SUBSTANCE
270-746-1	68477-65-6	649-120-00-0	Gases (petroleum), amine system feed
270-747-7	68477-66-7	649-121-00-6	Gases (petroleum), benzene unit hydrodesulfurizer off
270-748-2	68477-67-8	649-122-00-1	Gases (petroleum), benzene unit recycle, hydrogen-rich
270-749-8	68477-68-9	649-123-00-7	Gases (petroleum), blend oil, hydrogen-nitrogen-rich
270-759-2	68477-77-0	649-124-00-2	Gases (petroleum), catalytic reformed naphtha stripper overheads
270-761-3	68477-80-5	649-125-00-8	Gases (petroleum), C6-8 catalytic reformer recycle
270-762-9	68477-81-6	649-126-00-3	Gases (petroleum), C6-8 catalytic reformer
270-763-4	68477-82-7	649-127-00-9	Gases (petroleum), C6-8 catalytic reformer recycle, hydrogen-rich
270-766-0	68477-84-9	649-128-00-4	Gases (petroleum), C2-return stream
270-774-4	68477-92-9	649-129-00-X	Gases (petroleum), dry sour, gas-concn.-unit-off

270-776-5	68477-93-0	649-130-00-5	Gases (petroleum), gas concn. reabsorber distn.
270-779-1	68477-96-3	649-131-00-0	Gases (petroleum), hydrogen absorber off
270-780-7	68477-97-4	649-132-00-6	Gases (petroleum), hydrogen-rich
270-781-2	68477-98-5	649-133-00-1	Gases (petroleum), hydrotreater blend oil recycle, hydrogen-nitrogen-rich
270-783-3	68478-00-2	649-134-00-7	Gases (petroleum), recycle, hydrogen-rich
270-784-9	68478-01-3	649-135-00-2	Gases (petroleum), reformer make-up, hydrogen-rich
270-785-4	68478-02-4	649-136-00-8	Gases (petroleum), reforming hydrotreater
270-787-5	68478-03-5	649-137-00-3	Gases (petroleum), reforming hydrotreater, hydrogen-methane-rich
270-788-0	68478-04-6	649-138-00-9	Gases (petroleum), reforming hydrotreater make-up, hydrogen-rich
270-789-6	68478-05-7	649-139-00-4	Gases (petroleum), thermal cracking distn.
270-805-1	68478-25-1	649-140-00-X	Tail gas (petroleum), catalytic cracker refractionation absorber
270-807-2	68478-27-3	649-141-00-5	Tail gas (petroleum), catalytic reformed naphtha separator
270-808-8	68478-28-4	649-142-00-0	Tail gas (petroleum), catalytic reformed naphtha stabilizer
270-809-3	69478-29-5	649-143-00-6	Tail gas (petroleum), cracked distillate hydrotreater separator
270-810-9	68478-30-8	649-144-00-1	Tail gas (petroleum), hydrodesulfurized straight-run naphtha separator
270-999-8	68513-14-4	649-145-00-7	Gases (petroleum), catalytic reformed straight-run naphtha stabilizer overheads
271-003-4	68513-18-8	649-146-00-2	Gases (petroleum), reformer effluent high-pressure flash drum off
271-005-5	68513-19-9	649-147-00-8	Gases (petroleum), reformer effluent low-pressure flash drum off
271-258-1	68527-15-1	649-148-00-3	Gases (petroleum), oil refinery gas distn. off
271-623-5	68602-82-4	649-149-00-9	Gases (petroleum), benzene unit hydrotreater depentanizer overheads
271-625-6	68602-84-6	649-150-00-4	Gases (petroleum), secondary absorber off, fluidized catalytic cracker overheads fractionator
271-750-6	68607-11-4	649-151-00-X	Petroleum products, refinery gases
272-182-1	68783-06-2	649-152-00-5	Gases (petroleum), hydrocracking low-pressure separator
272-338-9	68814-67-5	649-153-00-0	Gases (petroleum), refinery
272-343-6	68814-90-4	649-154-00-6	Gases (petroleum), platformer products separator off
272-775-5	68911-58-0	649-155-00-1	Gases (petroleum), hydrotreated sour kerosine depentanizer stabilizer off
272-776-0	68911-59-1	649-156-00-7	Gases (petroleum), hydrotreated sour kerosine flash drum
272-873-8	68919-01-7	649-157-00-2	Gases (petroleum), distillate unifiner desulfurization stripper off
272-874-3	68919-02-8	649-158-00-8	Gases (petroleum), fluidized catalytic cracker fractionation off
272-875-9	68919-03-9	649-159-00-3	Gases (petroleum), fluidized catalytic cracker scrubbing secondary absorber off
272-876-4	68919-04-0	649-160-00-9	Gases (petroleum), heavy distillate hydrotreater desulfurization stripper off
272-880-6	68919-07-3	649-161-00-4	Gases (petroleum), platformer stabilizer off, light ends fractionation
272-881-1	68919-08-4	649-162-00-X	Gases (petroleum), preflash tower off, crude distn.
272-884-8	68919-11-9	649-163-00-5	Gases (petroleum), tar stripper off
272-885-3	68919-12-0	649-164-00-0	Gases (petroleum), unifiner stripper off
273-173-5	68952-79-4	649-165-00-6	Tail gas (petroleum), catalytic hydrodesulfurized naphtha separator
273-174-0	68952-80-7	649-166-00-1	Tail gas (petroleum), straight-run naphtha hydrodesulfurizer
273-269-7	68955-33-9	649-167-00-7	Gases (petroleum), sponge absorber off, fluidized catalytic cracker and gas oil desulfurizer overhead fractionation
273-563-5	68989-88-8	649-168-00-2	Gases (petroleum), crude distn. and catalytic cracking
295-397-2	92045-13-5	649-169-00-8	Gases (petroleum), gas oil diethanolamine scrubber off
295-398-8	92045-16-4	649-170-00-3	Gases (petroleum), gas oil hydrodesulfurization effluent
295-399-3	92045-17-5	649-171-00-9	Gases (petroleum), gas oil hydrodesulfurization purge
295-400-7	92045-18-6	649-172-00-4	Gases (petroleum), hydrogenator effluent flash drum off
295-401-2	92045-19-7	649-173-00-X	Gases (petroleum), naphtha steam cracking high-pressure residual
295-402-8	92045-20-0	649-174-00-5	Gases (petroleum), residue visbreaking off

RECLAIM PETROLEUM SUBSTANCES **Short name: Refinery reclaim substance**

EINECS	CAS No.	INDEX No.	SUBSTANCE
265-124-1	64742-24-1	NONE	Sludges (petroleum), acid
265-213-5	64743-07-3	NONE	Sludges (petroleum), chemically neutralized
270-692-9	68476-53-9	NONE	Hydrocarbons, C>=20, petroleum wastes
270-716-8	68477-26-9	NONE	Wastes, petroleum
272-867-5	68918-73-0	NONE	Residues (petroleum), clay-treating filter wash
273-314-0	68956-70-7	NONE	Petroleum products, C5-12, reclaimed, wastewater treatment
295-448-9	92045-66-4	NONE	Naphtha (petroleum), sulfurized light, sweetening catalyst regeneration
295-521-5	92062-07-2	NONE	Residues (petroleum), wastewater purifn. dense-phase separator

295-526-2	92062-12-9	NONE	Slimes and Sludges, petroleum refining
297-488-2	93572-57-7	NONE	Petroleum products, C>5, reclaimed, wastewater treatment
308-527-0	98072-71-0	NONE	Wastewater, petroleum-refining
309-943-5	101631-18-9	NONE	Hydrocarbon oils, lubricating oil manuf. waste skimmings

OTHER PETROLEUM SUBSTANCES **Short name: Petroleum substance - unspecified**

EINECS	CAS No.	INDEX No.	SUBSTANCE
232-384-2	8012-95-1	NONE	Paraffin oils
265-087-1	64741-85-1	NONE	Raffinates (petroleum), sorption process
265-116-8	64742-16-1	NONE	Petroleum resins
265-233-4	64771-72-8	NONE	Paraffins (petroleum), normal C5-20
270-072-8	69410-00-4	NONE	Distillates (petroleum), crude oil
270-739-3	68477-58-7	NONE	Distillates (petroleum), steam-cracked petroleum distillates, C5-18 fraction
272-930-7	68921-07-3	NONE	Distillates (petroleum), hydrotreated light catalytic cracked
274-686-7	70592-79-9	NONE	Residues (petroleum), atm. tower, light
292-655-6	90669-60-6	NONE	Pitch, petroleum, arom., distillates
293-299-4	91053-35-9	NONE	Kerosine (petroleum), high-boiling fraction
295-307-1	91995-46-9	NONE	Distillates (petroleum), hydrotreated full-range
295-317-6	91995-55-0	NONE	Distillates (petroleum), steam-cracked residue, arom.
295-513-1	92061-99-9	NONE	Residues (petroleum), hydrocracked, light end-contg.
308-252-6	97926-35-7	NONE	Distillates (petroleum), full-range steam-cracked, arom.-contg.

ANNEX IIB

Petroleum Substances (EINECS No. order) with short names

EINECS	CAS No.	INDEX No.	GROUP (SHORT NAME)
200-827-9	74-98-6	601-003-00-5	PETROLEUM GAS
203-448-7	106-97-8	601-004-00-0	PETROLEUM GAS
232-298-5	8002-05-9	649-049-00-5	CRUDE OIL
232-315-6	8002-74-2	NONE	PETROLEUM WAX
232-349-1	8006-61-9	649-261-00-8	LOW BOILING POINT NAPHTHA
232-366-4	8008-20-6	649-404-00-4	STRAIGHT RUN KEROSINE
232-373-2	8009-03-8	649-254-00-X	PETROLATUM
232-384-2	8012-95-1	NONE	PETROLEUM SUBSTANCE - UNSPECIFIED
232-443-2	8030-30-6	649-262-00-3	LOW BOILING POINT NAPHTHA
232-453-7	8032-32-4	649-263-00-9	LOW BOILING POINT NAPHTHA
232-455-8	8042-47-5	NONE	HIGHLY REFINED BASE OIL
232-489-3	8052-41-3	649-345-00-4	LOW BOILING POINT NAPHTHA - UNSPECIFIED
232-490-9	8052-42-4	NONE	BITUMEN OR VACUUM RESIDUE
264-038-1	63231-60-7	NONE	PETROLEUM WAX
265-041-0	64741-41-9	649-264-00-4	LOW BOILING POINT NAPHTHA
265-042-6	64741-42-0	649-265-00-X	LOW BOILING POINT NAPHTHA
265-043-1	64741-43-1	NONE	STRAIGHT RUN GAS OIL
265-044-7	64741-44-2	NONE	STRAIGHT RUN GAS OIL
265-045-2	64741-45-3	649-008-00-1	HEAVY FUEL OIL
265-046-8	64741-46-4	649-266-00-5	LOW BOILING POINT NAPHTHA
265-047-3	64741-47-5	649-346-00-X	LOW BOILING POINT NAPHTHA - UNSPECIFIED
265-048-9	64741-48-6	649-347-00-5	LOW BOILING POINT NAPHTHA - UNSPECIFIED
265-049-4	64741-49-7	NONE	VACUUM GAS OIL
265-051-5	64741-50-0	649-050-00-0	UNREFINED OR MILDLY REFINED BASE OIL
265-052-0	64741-51-1	649-051-00-6	UNREFINED OR MILDLY REFINED BASE OIL
265-053-6	64741-52-2	649-052-00-1	UNREFINED OR MILDLY REFINED BASE OIL
265-054-1	64741-53-3	649-053-00-7	UNREFINED OR MILDLY REFINED BASE OIL
265-055-7	64741-54-4	649-289-00-0	LOW BOILING POINT CAT-CRACKED NAPHTHA
265-056-2	64741-55-5	649-290-00-6	LOW BOILING POINT CAT-CRACKED NAPHTHA
265-057-8	64741-56-6	NONE	BITUMEN OR VACUUM RESIDUE
265-058-3	64741-57-7	649-009-00-7	HEAVY FUEL OIL
265-059-9	64741-58-8	NONE	VACUUM GAS OIL
265-060-4	64741-59-9	649-435-00-3	CRACKED GAS OIL
265-062-5	64741-60-2	649-436-00-9	CRACKED GAS OIL

EINECS	CAS No.	INDEX No.	GROUP (SHORT NAME)
265-063-0	64741-61-3	649-010-00-2	HEAVY FUEL OIL
265-064-6	64741-62-4	649-011-00-8	HEAVY FUEL OIL
265-065-1	64741-63-5	649-299-00-5	LOW BOILING POINT CAT-REFORMED NAPHTHA
265-066-7	64741-64-6	649-274-00-9	LOW BOILING POINT MODIFIED NAPHTHA
265-067-2	64741-65-7	649-275-00-4	LOW BOILING POINT MODIFIED NAPHTHA
265-068-8	64741-66-8	649-276-00-X	LOW BOILING POINT MODIFIED NAPHTHA
265-069-3	64741-67-9	649-048-00-X	HEAVY FUEL OIL
265-070-9	64741-68-0	649-300-00-9	LOW BOILING POINT CAT-REFORMED NAPHTHA
265-071-4	64741-69-1	649-348-00-0	LOW BOILING POINT NAPHTHA - UNSPECIFIED
265-073-5	64741-70-4	649-277-00-5	LOW BOILING POINT MODIFIED NAPHTHA
265-074-0	64741-73-7	649-419-00-6	KEROSINE - UNSPECIFIED
265-075-6	64741-74-8	649-316-00-6	LOW BOILING POINT THERMALLY CRACKED NAPHTHA
265-076-1	64741-75-9	649-012-00-3	HEAVY FUEL OIL
265-077-7	64741-76-0	649-453-00-1	BASE OIL - UNSPECIFIED
265-078-2	64741-77-1	649-437-00-4	CRACKED GAS OIL (HYDROCRACKED GAS OIL)
265-079-8	64741-78-2	649-349-00-6	LOW BOILING POINT NAPHTHA - UNSPECIFIED
265-080-3	64741-79-3	NONE	PETROLEUM COKE
265-081-9	64741-80-6	649-013-00-9	HEAVY FUEL OIL
265-082-4	64741-81-7	649-014-00-4	HEAVY FUEL OIL
265-084-5	64741-82-8	649-438-00-X	CRACKED GAS OIL
265-085-0	64741-83-9	649-317-00-1	LOW BOILING POINT THERMALLY CRACKED NAPHTHA
265-086-6	64741-84-0	649-278-00-0	LOW BOILING POINT MODIFIED NAPHTHA
265-087-1	64741-85-1	NONE	PETROLEUM SUBSTANCE - UNSPECIFIED
265-088-7	64741-86-2	649-212-00-0	GAS OIL - UNSPECIFIED (OTHER GAS OILS)
265-089-2	64741-87-3	649-350-00-1	LOW BOILING POINT NAPHTHA – UNSPECIFIED
265-090-8	64741-88-4	649-454-00-7	BASE OIL - UNSPECIFIED
265-091-3	64741-89-5	649-455-00-2	BASE OIL - UNSPECIFIED
265-092-9	64741-90-8	649-213-00-6	GAS OIL - UNSPECIFIED (OTHER GAS OILS)
265-093-4	64741-91-9	649-214-00-1	GAS OIL - UNSPECIFIED (OTHER GAS OILS)
265-095-5	64741-92-0	649-279-00-6	LOW BOILING POINT MODIFIED NAPHTHA
265-096-0	64741-95-3	649-456-00-8	BASE OIL - UNSPECIFIED
265-097-6	64741-96-4	649-457-00-3	BASE OIL - UNSPECIFIED
265-098-1	64741-97-5	649-458-00-9	BASE OIL - UNSPECIFIED
265-099-7	64741-98-6	649-420-00-1	KEROSINE - UNSPECIFIED
265-101-6	64742-01-4	649-459-00-4	BASE OIL - UNSPECIFIED
265-102-1	64742-03-6	649-001-00-3	DISTILLATE AROMATIC EXTRACT
265-103-7	64742-04-7	649-002-00-9	DISTILLATE AROMATIC EXTRACT
265-104-2	64742-05-8	649-003-00-4	DISTILLATE AROMATIC EXTRACT
265-105-8	64742-06-9	NONE	AROMATIC EXTRACT - UNSPECIFIED
265-110-5	64742-10-5	NONE	RESIDUAL AROMATIC EXTRACT
265-111-0	64742-11-6	649-004-00-X	DISTILLATE AROMATIC EXTRACT
265-112-6	64742-12-7	649-215-00-7	GAS OIL - UNSPECIFIED (OTHER GAS OILS)
265-113-1	64742-13-8	649-216-00-2	GAS OIL - UNSPECIFIED (OTHER GAS OILS)
265-114-7	64742-14-9	649-217-00-8	GAS OIL - UNSPECIFIED (OTHER GAS OILS)
265-115-2	64742-15-0	649-351-00-7	LOW BOILING POINT NAPHTHA - UNSPECIFIED
265-116-8	64742-16-1	NONE	PETROLEUM SUBSTANCE - UNSPECIFIED
265-117-3	64742-18-3	649-054-00-2	UNREFINED OR MILDLY REFINED BASE OIL
265-118-9	64742-19-4	649-055-00-8	UNREFINED OR MILDLY REFINED BASE OIL
265-119-4	64742-20-7	649-056-00-3	UNREFINED OR MILDLY REFINED BASE OIL
265-121-5	64742-21-8	649-057-00-9	UNREFINED OR MILDLY REFINED BASE OIL
265-122-0	64742-22-9	649-352-00-2	LOW BOILING POINT NAPHTHA - UNSPECIFIED
265-123-6	64742-23-0	649-353-00-8	LOW BOILING POINT NAPHTHA - UNSPECIFIED
265-124-1	64742-24-1	NONE	REFINERY RECLAIM SUBSTANCE
265-125-7	64742-25-2	NONE	USED OR RE-REFINED OIL
265-126-2	64742-26-3	NONE	PETROLEUM WAX
265-127-8	64742-27-4	649-058-00-4	UNREFINED OR MILDLY REFINED BASE OIL
265-128-3	64742-28-5	649-059-00-X	UNREFINED OR MILDLY REFINED BASE OIL
265-129-9	64742-29-6	649-218-00-3	GAS OIL - UNSPECIFIED (OTHER GAS OILS)
265-130-4	64742-30-9	649-219-00-9	GAS OIL - UNSPECIFIED (OTHER GAS OILS)
265-132-5	64742-31-0	649-421-00-7	KEROSINE - UNSPECIFIED
265-133-0	64742-32-1	NONE	USED OR RE-REFINED OIL
265-134-6	64742-33-2	NONE	PETROLEUM WAX
265-135-1	64742-34-3	649-060-00-5	UNREFINED OR MILDLY REFINED BASE OIL
265-136-7	64742-35-4	649-061-00-0	UNREFINED OR MILDLY REFINED BASE OIL
265-137-2	64742-36-5	649-460-00-X	BASE OIL - UNSPECIFIED
265-138-8	64742-37-6	649-461-00-5	BASE OIL - UNSPECIFIED
265-139-3	64742-38-7	649-220-00-4	GAS OIL - UNSPECIFIED (OTHER GAS OILS)

EINECS	CAS No.	INDEX No.	GROUP (SHORT NAME)
265-143-5	64742-41-2	649-462-00-0	BASE OIL - UNSPECIFIED
265-144-0	64742-42-3	NONE	PETROLEUM WAX
265-145-6	64742-43-4	NONE	PETROLEUM WAX
265-146-1	64742-44-5	649-463-00-6	BASE OIL - UNSPECIFIED
265-147-7	64742-45-6	649-464-00-1	BASE OIL - UNSPECIFIED
265-148-2	64742-46-7	649-221-00-X	GAS OIL - UNSPECIFIED (OTHER GAS OILS)
265-149-8	64742-47-8	649-422-00-2	KEROSINE - UNSPECIFIED
265-150-3	64742-48-9	649-327-00-6	LOW BOILING POINT HYDROGEN TREATED NAPHTHA
265-151-9	64742-49-0	649-328-00-1	LOW BOILING POINT HYDROGEN TREATED NAPHTHA
265-152-4	64742-50-3	NONE	USED OR RE-REFINED OIL
265-154-5	64742-51-4	NONE	PETROLEUM WAX
265-155-0	64742-52-5	649-465-00-7	BASE OIL - UNSPECIFIED
265-156-6	64742-53-6	649-466-00-2	BASE OIL - UNSPECIFIED
265-157-1	64742-54-7	649-467-00-8	BASE OIL - UNSPECIFIED
265-158-7	64742-55-8	649-468-00-3	BASE OIL - UNSPECIFIED
265-159-2	64742-56-9	649-469-00-9	BASE OIL - UNSPECIFIED
265-160-8	64742-57-0	649-470-00-4	BASE OIL - UNSPECIFIED
265-161-3	64742-58-1	NONE	USED OR RE-REFINED OIL
265-162-9	64742-59-2	649-015-00-X	HEAVY FUEL OIL
265-163-4	64742-60-5	NONE	PETROLEUM WAX
265-165-5	64742-61-6	649-244-00-5	SLACK WAX
265-166-0	64742-62-7	649-471-00-X	BASE OIL - UNSPECIFIED
265-167-6	64742-63-8	649-472-00-5	BASE OIL - UNSPECIFIED
265-168-1	64742-64-9	649-473-00-0	BASE OIL – UNSPECIFIED
265-169-7	64742-65-0	649-474-00-6	BASE OIL – UNSPECIFIED
265-170-2	64742-66-1	649-354-00-3	LOW BOILING POINT NAPHTHA - UNSPECIFIED
265-171-8	64742-67-2	649-549-00-3	FOOTS OIL
265-172-3	64742-68-3	649-475-00-1	BASE OIL - UNSPECIFIED
265-173-9	64742-69-4	649-476-00-7	BASE OIL - UNSPECIFIED
265-174-4	64742-70-7	649-477-00-2	BASE OIL - UNSPECIFIED
265-176-5	64742-71-8	649-478-00-8	BASE OIL - UNSPECIFIED
265-178-6	64742-73-0	649-329-00-7	LOW BOILING POINT HYDROGEN TREATED NAPHTHA
265-179-1	64742-75-2	649-479-00-3	BASE OIL - UNSPECIFIED
265-180-7	64742-76-3	649-480-00-9	BASE OIL - UNSPECIFIED
265-181-2	64742-78-5	649-016-00-5	HEAVY FUEL OIL
265-182-8	64742-79-6	649-222-00-5	GAS OIL - UNSPECIFIED (OTHER GAS OILS)
265-183-3	64742-80-9	649-223-00-0	GAS OIL - UNSPECIFIED (OTHER GAS OILS)
265-184-9	64742-81-0	649-423-00-8	KEROSINE - UNSPECIFIED
265-185-4	64742-82-1	649-330-00-2	LOW BOILING POINT HYDROGEN TREATED NAPHTHA
265-187-5	64742-83-2	649-355-00-9	LOW BOILING POINT NAPHTHA - UNSPECIFIED
265-188-0	64742-85-4	NONE	BITUMEN OR VACUUM RESIDUE
265-189-6	64742-86-5	649-017-00-0	HEAVY FUEL OIL
265-190-1	64742-87-6	NONE	VACUUM GAS OIL
265-191-7	64742-88-7	649-405-00-X	STRAIGHT RUN KEROSINE
265-192-2	64742-89-8	649-267-00-0	LOW BOILING POINT NAPHTHA
265-193-8	64742-90-1	649-018-00-6	HEAVY FUEL OIL
265-194-3	64742-91-2	649-408-00-6	CRACKED KEROSINE
265-196-4	64742-93-4	NONE	BITUMEN OR VACUUM RESIDUE
265-198-5	64742-94-5	649-424-00-3	KEROSINE - UNSPECIFIED
265-199-0	64742-95-6	649-356-00-4	LOW BOILING POINT NAPHTHA - UNSPECIFIED
265-200-4	64742-96-7	649-406-00-5	STRAIGHT RUN KEROSINE
265-206-7	64743-01-7	649-255-00-5	PETROLATUM
265-209-3	64743-04-0	NONE	PETROLEUM COKE
265-210-9	64743-05-1	NONE	PETROLEUM COKE
265-211-4	64743-06-2	NONE	AROMATIC EXTRACT - UNSPECIFIED
265-213-5	64743-07-3	NONE	REFINERY RECLAIM SUBSTANCE
265-233-4	64771-72-8	NONE	PETROLEUM SUBSTANCE - UNSPECIFIED
267-563-4	67891-79-6	649-318-00-7	LOW BOILING POINT THERMALLY CRACKED NAPHTHA
267-565-5	67891-80-9	649-319-00-2	LOW BOILING POINT THERMALLY CRACKED NAPHTHA
268-618-5	68131-49-7	649-357-00-X	LOW BOILING POINT NAPHTHA - UNSPECIFIED
268-629-5	68131-75-9	649-177-00-1	PETROLEUM GAS
269-617-2	68307-98-2	649-178-00-7	PETROLEUM GAS
269-618-8	68307-99-3	649-179-00-2	PETROLEUM GAS
269-619-3	68308-00-9	649-180-00-8	PETROLEUM GAS
269-620-9	68308-01-0	649-181-00-3	PETROLEUM GAS
269-623-5	68308-03-2	649-183-00-4	PETROLEUM GAS
269-624-0	68308-04-3	649-184-00-X	PETROLEUM GAS

EINECS	CAS No.	INDEX No.	GROUP (SHORT NAME)
269-625-6	68308-05-4	649-185-00-5	PETROLEUM GAS
269-626-1	68308-06-5	649-186-00-0	PETROLEUM GAS
269-627-7	68308-07-6	649-187-00-6	PETROLEUM GAS
269-628-2	68308-08-7	649-210-00-X	PETROLEUM GAS
269-629-8	68308-09-8	649-188-00-1	PETROLEUM GAS
269-630-3	68308-10-1	649-182-00-9	PETROLEUM GAS
269-631-9	68308-11-2	649-189-00-7	PETROLEUM GAS
269-632-4	68308-12-3	649-190-00-2	PETROLEUM GAS
269-777-3	68333-22-2	649-019-00-1	HEAVY FUEL OIL
269-778-9	68333-23-3	649-425-00-9	KEROSINE - UNSPECIFIED
269-781-5	68333-25-5	649-439-00-5	CRACKED GAS OIL
269-782-0	68333-26-6	649-020-00-7	HEAVY FUEL OIL
269-783-6	68333-27-7	649-021-00-2	HEAVY FUEL OIL
269-784-1	68333-28-8	649-022-00-8	HEAVY FUEL OIL
269-822-7	68334-30-5	649-224-00-6	GAS OIL - UNSPECIFIED (DIST. FUEL OILS)
270-071-2	68409-99-4	649-191-00-8	PETROLEUM GAS
270-072-8	69410-00-4	NONE	PETROLEUM SUBSTANCE - UNSPECIFIED
270-077-5	68410-05-9	649-268-00-6	LOW BOILING POINT NAPHTHA
270-088-5	68410-71-9	649-280-00-1	LOW BOILING POINT MODIFIED NAPHTHA
270-092-7	68410-96-8	649-331-00-8	LOW BOILING POINT HYDROGEN TREATED NAPHTHA
270-093-2	68410-97-9	649-332-00-3	LOW BOILING POINT HYDROGEN TREATED NAPHTHA
270-094-8	68410-98-0	649-333-00-9	LOW BOILING POINT HYDROGEN TREATED NAPHTHA
270-344-6	68425-29-6	649-320-00-8	LOW BOILING POINT THERMALLY CRACKED NAPHTHA
270-349-3	68425-35-4	649-281-00-7	LOW BOILING POINT MODIFIED NAPHTHA
270-651-5	68475-57-0	649-193-00-9	PETROLEUM GAS
270-652-0	68475-58-1	649-194-00-4	PETROLEUM GAS
270-653-6	68475-59-2	649-195-00-X	PETROLEUM GAS
270-654-1	68475-60-5	649-196-00-5	PETROLEUM GAS
270-658-3	68475-70-7	649-321-00-3	LOW BOILING POINT THERMALLY CRACKED NAPHTHA
270-660-4	68475-79-6	649-301-00-4	LOW BOILING POINT CAT-REFORMED NAPHTHA
270-662-5	68475-80-9	649-440-00-0	CRACKED GAS OIL
270-667-2	68476-26-6	649-197-00-0	PETROLEUM GAS
270-670-9	68476-29-9	649-198-00-6	PETROLEUM GAS
270-671-4	68476-30-2	649-225-00-2	GAS OIL - UNSPECIFIED (DIST. FUEL OILS)
270-673-5	68476-31-3	649-226-00-7	GAS OIL - UNSPECIFIED (DIST. FUEL OILS)
270-674-0	68476-32-4	649-023-00-3	HEAVY FUEL OIL
270-675-6	68476-33-5	649-024-00-9	HEAVY FUEL OIL
270-676-1	68476-34-6	649-227-00-2	GAS OIL - UNSPECIFIED (DIST. FUEL OILS)
270-681-9	68476-40-4	649-199-00-1	PETROLEUM GAS
270-682-4	68476-42-6	649-200-00-5	PETROLEUM GAS
270-686-6	68476-46-0	649-291-00-1	LOW BOILING POINT CAT-CRACKED NAPHTHA
270-687-1	68476-47-1	649-302-00-X	LOW BOILING POINT CAT-REFORMED NAPHTHA
270-689-2	68476-49-3	649-201-00-0	PETROLEUM GAS
270-690-8	68476-50-6	649-401-00-8	LOW BOILING POINT NAPHTHA - UNSPECIFIED
270-692-9	68476-53-9	NONE	REFINERY RECLAIM SUBSTANCE
270-695-5	68476-55-1	649-402-00-3	LOW BOILING POINT NAPHTHA - UNSPECIFIED
270-697-6	68476-77-7	NONE	USED OR RE-REFINED OIL
270-704-2	68476-85-7	649-202-00-6	PETROLEUM GAS
270-705-8	68476-86-8	649-203-00-1	PETROLEUM GAS
270-716-8	68477-26-9	NONE	REFINERY RECLAIM SUBSTANCE
270-719-4	68477-29-2	649-228-00-8	GAS OIL - UNSPECIFIED (OTHER GAS OILS)
270-721-5	68477-30-5	649-229-00-3	GAS OIL - UNSPECIFIED (OTHER GAS OILS)
270-722-0	68477-31-6	649-230-00-9	GAS OIL - UNSPECIFIED (OTHER GAS OILS)
270-724-1	68477-33-8	649-204-00-7	PETROLEUM GAS
270-725-7	68477-34-9	649-358-00-5	LOW BOILING POINT NAPHTHA - UNSPECIFIED
270-726-2	68477-35-0	649-205-00-2	PETROLEUM GAS
270-727-8	68477-38-3	649-441-00-6	CRACKED GAS OIL
270-728-3	68477-39-4	649-409-00-1	CRACKED KEROSINE
270-729-9	68477-40-7	649-410-00-7	CRACKED KEROSINE
270-735-1	68477-50-9	649-359-00-0	LOW BOILING POINT NAPHTHA - UNSPECIFIED
270-736-7	68477-53-2	649-360-00-6	LOW BOILING POINT NAPHTHA - UNSPECIFIED
270-737-2	68477-54-3	649-411-00-2	CRACKED KEROSINE
270-738-8	68477-55-4	NONE	LOW BOILING POINT NAPHTHA - UNSPECIFIED
270-739-3	68477-58-7	NONE	PETROLEUM SUBSTANCE - UNSPECIFIED
270-741-4	68477-61-2	NONE	LOW BOILING POINT NAPHTHA - UNSPECIFIED
270-746-1	68477-65-6	649-120-00-0	REFINERY GAS
270-747-7	68477-66-7	649-121-00-6	REFINERY GAS

EINECS	CAS No.	INDEX No.	GROUP (SHORT NAME)
270-748-2	68477-67-8	649-122-00-1	REFINERY GAS
270-749-8	68477-68-9	649-123-00-7	REFINERY GAS
270-750-3	68477-69-0	649-206-00-3	PETROLEUM GAS
270-751-9	68477-70-3	649-207-00-3	PETROLEUM GAS
270-752-4	68477-71-4	649-208-00-9	PETROLEUM GAS
270-754-5	68477-72-5	649-209-00-4	PETROLEUM GAS
270-755-0	68477-73-6	649-062-00-6	PETROLEUM GAS
270-756-6	68477-74-7	649-063-00-1	PETROLEUM GAS
270-757-1	68477-75-8	649-064-00-7	PETROLEUM GAS
270-758-7	68477-76-9	649-065-00-2	PETROLEUM GAS
270-759-2	68477-77-0	649-124-00-2	REFINERY GAS
270-760-8	68477-79-2	649-066-00-8	PETROLEUM GAS
270-761-3	68477-80-5	649-125-00-8	REFINERY GAS
270-762-9	68477-81-6	649-126-00-3	REFINERY GAS
270-763-4	68477-82-7	649-127-00-9	REFINERY GAS
270-765-5	68477-83-8	649-067-00-3	PETROLEUM GAS
270-766-0	68477-84-9	649-128-00-4	REFINERY GAS
270-767-6	68477-85-0	649-068-00-9	PETROLEUM GAS
270-768-1	68477-86-1	649-069-00-4	PETROLEUM GAS
270-769-7	68477-87-2	649-070-00-X	PETROLEUM GAS
270-771-8	68477-89-4	649-363-00-2	LOW BOILING POINT NAPHTHA - UNSPECIFIED
270-772-3	68477-90-7	649-071-00-5	PETROLEUM GAS
270-773-9	68477-91-8	649-072-00-0	PETROLEUM GAS
270-774-4	68477-92-9	649-129-00-X	REFINERY GAS
270-776-5	68477-93-0	649-130-00-5	REFINERY GAS
270-777-0	68477-94-1	649-073-00-6	PETROLEUM GAS
270-778-6	68477-95-2	649-074-00-1	PETROLEUM GAS
270-779-1	68477-96-3	649-131-00-0	REFINERY GAS
270-780-7	68477-97-4	649-132-00-6	REFINERY GAS
270-781-2	68477-98-5	649-133-00-1	REFINERY GAS
270-782-8	68477-99-6	649-075-00-7	PETROLEUM GAS
270-783-3	68478-00-2	649-134-00-7	REFINERY GAS
270-784-9	68478-01-3	649-135-00-2	REFINERY GAS
270-785-4	68478-02-4	649-136-00-8	REFINERY GAS
270-787-5	68478-03-5	649-137-00-3	REFINERY GAS
270-788-0	68478-04-6	649-138-00-9	REFINERY GAS
270-789-6	68478-05-7	649-139-00-4	REFINERY GAS
270-791-7	68478-12-6	649-364-00-8	LOW BOILING POINT NAPHTHA - UNSPECIFIED
270-792-2	68478-13-7	649-025-00-4	HEAVY FUEL OIL
270-794-3	68478-15-9	649-303-00-5	LOW BOILING POINT CAT-REFORMED NAPHTHA
270-795-9	68478-16-0	649-365-00-3	LOW BOILING POINT NAPHTHA - UNSPECIFIED
270-796-4	68478-17-1	649-026-00-X	HEAVY FUEL OIL
270-802-5	68478-21-7	649-076-00-2	PETROLEUM GAS
270-803-0	68478-22-8	649-077-00-8	PETROLEUM GAS
270-804-6	68478-24-0	649-078-00-3	PETROLEUM GAS
270-805-1	68478-25-1	649-140-00-X	REFINERY GAS
270-806-7	68478-26-2	649-079-00-9	PETROLEUM GAS
270-807-2	68478-27-3	649-141-00-5	REFINERY GAS
270-808-8	68478-28-4	649-142-00-0	REFINERY GAS
270-809-3	69478-29-5	649-143-00-6	REFINERY GAS
270-810-9	68478-30-8	649-144-00-1	REFINERY GAS
270-813-5	68478-32-0	649-080-00-4	PETROLEUM GAS
270-814-0	68478-33-1	649-081-00-X	PETROLEUM GAS
270-815-6	68478-34-2	649-082-00-5	PETROLEUM GAS
270-983-0	68512-61-8	649-027-00-5	HEAVY FUEL OIL
270-984-6	68512-62-9	649-028-00-0	HEAVY FUEL OIL
270-988-8	68512-78-7	649-334-00-4	LOW BOILING POINT HYDROGEN TREATED NAPHTHA
270-990-9	68512-91-4	649-083-00-0	PETROLEUM GAS
270-991-4	68513-02-0	649-366-00-9	LOW BOILING POINT NAPHTHA - UNSPECIFIED
270-993-5	68513-03-1	649-304-00-0	LOW BOILING POINT CAT-REFORMED NAPHTHA
270-999-8	68513-14-4	649-145-00-7	REFINERY GAS
271-000-8	68513-15-5	649-084-00-6	PETROLEUM GAS
271-001-3	68513-16-6	649-085-00-1	PETROLEUM GAS
271-002-9	68513-17-7	649-086-00-7	PETROLEUM GAS
271-003-4	68513-18-8	649-146-00-2	REFINERY GAS
271-005-5	68513-19-9	649-147-00-8	REFINERY GAS
271-008-1	68513-63-3	649-305-00-6	LOW BOILING POINT CAT-REFORMED NAPHTHA

EINECS	CAS No.	INDEX No.	GROUP (SHORT NAME)
271-010-2	68513-66-6	649-087-00-2	PETROLEUM GAS
271-013-9	68513-69-9	649-029-00-6	HEAVY FUEL OIL
271-025-4	68514-15-8	649-269-00-1	LOW BOILING POINT NAPHTHA
271-032-2	68514-31-8	649-088-00-8	PETROLEUM GAS
271-038-5	68514-36-3	649-089-00-3	PETROLEUM GAS
271-058-4	68514-79-4	649-306-00-1	LOW BOILING POINT CAT-REFORMED NAPHTHA
271-138-9	68516-20-1	649-367-00-4	LOW BOILING POINT NAPHTHA - UNSPECIFIED
271-258-1	68527-15-1	649-148-00-3	REFINERY GAS
271-259-7	68527-16-2	649-090-00-9	PETROLEUM GAS
271-260-2	68527-18-4	649-442-00-1	CRACKED GAS OIL
271-261-8	68527-19-5	649-091-00-4	PETROLEUM GAS
271-262-3	68527-21-9	649-368-00-X	LOW BOILING POINT NAPHTHA - UNSPECIFIED
271-263-9	68527-22-0	649-369-00-5	LOW BOILING POINT NAPHTHA - UNSPECIFIED
271-264-4	68527-23-1	649-370-00-0	LOW BOILING POINT NAPHTHA - UNSPECIFIED
271-266-5	68527-26-4	649-371-00-6	LOW BOILING POINT NAPHTHA - UNSPECIFIED
271-267-0	68527-27-5	649-282-00-2	LOW BOILING POINT MODIFIED NAPHTHA
271-384-7	68553-00-4	649-030-00-1	HEAVY FUEL OIL
271-623-5	68602-82-4	649-149-00-9	REFINERY GAS
271-624-0	68602-83-5	649-092-00-X	PETROLEUM GAS
271-625-6	68602-84-6	649-150-00-4	REFINERY GAS
271-631-9	68603-00-9	649-322-00-9	LOW BOILING POINT THERMALLY CRACKED NAPHTHA
271-632-4	68603-01-0	649-323-00-4	LOW BOILING POINT THERMALLY CRACKED NAPHTHA
271-634-5	68603-03-2	649-324-00-X	LOW BOILING POINT THERMALLY CRACKED NAPHTHA
271-635-0	68603-08-7	649-372-00-1	LOW BOILING POINT NAPHTHA - UNSPECIFIED
271-726-5	68606-10-0	649-373-00-7	LOW BOILING POINT NAPHTHA – UNSPECIFIED
271-727-0	68606-11-1	649-270-00-7	LOW BOILING POINT NAPHTHA
271-734-9	68606-25-7	649-093-00-5	PETROLEUM GAS
271-735-4	68606-26-8	649-094-00-0	PETROLEUM GAS
271-737-5	68606-27-9	649-095-00-6	PETROLEUM GAS
271-742-2	68606-34-8	649-096-00-1	PETROLEUM GAS
271-750-6	68607-11-4	649-151-00-X	REFINERY GAS
271-763-7	68607-30-7	649-031-00-7	HEAVY FUEL OIL
272-173-2	68782-98-9	NONE	AROMATIC EXTRACT - UNSPECIFIED
272-174-8	68782-99-0	NONE	AROMATIC EXTRACT - UNSPECIFIED
272-175-3	68783-00-6	649-531-00-5	DISTILLATE AROMATIC EXTRACT (TREATED)
272-177-4	68783-02-8	NONE	AROMATIC EXTRACT - UNSPECIFIED
272-179-5	68783-03-9	NONE	AROMATIC EXTRACT - UNSPECIFIED
272-180-0	68783-04-0	649-532-00-0	DISTILLATE AROMATIC EXTRACT (TREATED)
272-182-1	68783-06-2	649-152-00-5	REFINERY GAS
272-183-7	68783-07-3	649-097-00-7	PETROLEUM GAS
272-184-2	68783-08-4	649-032-00-2	HEAVY FUEL OIL
272-185-8	68783-09-5	649-292-00-7	LOW BOILING POINT CAT-CRACKED NAPHTHA
272-186-3	68783-12-0	649-271-00-2	LOW BOILING POINT NAPHTHA
272-187-9	68783-13-1	649-033-00-8	HEAVY FUEL OIL
272-203-4	68783-64-2	649-098-00-2	PETROLEUM GAS
272-205-5	68783-65-3	649-099-00-8	PETROLEUM GAS
272-206-0	68783-66-4	649-374-00-2	LOW BOILING POINT NAPHTHA - UNSPECIFIED
272-338-9	68814-67-5	649-153-00-0	REFINERY GAS
272-341-5	68814-87-9	NONE	STRAIGHT RUN GAS OIL
272-342-0	68814-89-1	649-533-00-6	DISTILLATE AROMATIC EXTRACT (TREATED)
272-343-6	68814-90-4	649-154-00-6	REFINERY GAS
272-775-5	68911-58-0	649-155-00-1	REFINERY GAS
272-776-0	68911-59-1	649-156-00-7	REFINERY GAS
272-817-2	68915-96-8	NONE	STRAIGHT RUN GAS OIL
272-818-8	68915-97-9	NONE	STRAIGHT RUN GAS OIL
272-867-5	68918-73-0	NONE	REFINERY RECLAIM SUBSTANCE
272-871-7	68918-99-0	649-100-00-1	PETROLEUM GAS
272-872-2	68919-00-6	649-101-00-7	PETROLEUM GAS
272-873-8	68919-01-7	649-157-00-2	REFINERY GAS
272-874-3	68919-02-8	649-158-00-8	REFINERY GAS
272-875-9	68919-03-9	649-159-00-3	REFINERY GAS
272-876-4	68919-04-0	649-160-00-9	REFINERY GAS
272-878-5	68919-05-1	649-102-00-2	PETROLEUM GAS
272-879-0	68919-06-2	649-103-00-8	PETROLEUM GAS
272-880-6	68919-07-3	649-161-00-4	REFINERY GAS
272-881-1	68919-08-4	649-162-00-X	REFINERY GAS
272-882-7	68919-09-5	649-104-00-3	PETROLEUM GAS

EINECS	CAS No.	INDEX No.	GROUP (SHORT NAME)
272-883-2	68919-10-8	649-106-00-4	PETROLEUM GAS
272-884-8	68919-11-9	649-163-00-5	REFINERY GAS
272-885-3	68919-12-0	649-164-00-0	REFINERY GAS
272-893-7	68919-20-0	649-105-00-9	PETROLEUM GAS
272-895-8	68919-37-9	649-307-00-7	LOW BOILING POINT CAT-REFORMED NAPHTHA
272-896-3	68919-39-1	649-375-00-8	LOW BOILING POINT NAPHTHA - UNSPECIFIED
272-930-7	68921-07-3	NONE	PETROLEUM SUBSTANCE - UNSPECIFIED
272-931-2	68921-08-4	649-272-00-8	LOW BOILING POINT NAPHTHA
272-932-8	68921-09-5	649-376-00-3	LOW BOILING POINT NAPHTHA - UNSPECIFIED
273-169-3	68952-76-1	649-107-00-X	PETROLEUM GAS
273-170-9	68952-77-2	649-108-00-5	PETROLEUM GAS
273-173-5	68952-79-4	649-165-00-6	REFINERY GAS
273-174-0	68952-80-7	649-166-00-1	REFINERY GAS
273-175-6	68952-81-8	649-109-00-0	PETROLEUM GAS
273-176-1	68952-82-9	649-110-00-6	PETROLEUM GAS
273-263-4	68955-27-1	649-034-00-3	HEAVY FUEL OIL
273-265-5	68955-28-2	649-111-00-1	PETROLEUM GAS
273-266-0	68955-29-3	649-325-00-5	LOW BOILING POINT THERMALLY CRACKED NAPHTHA
273-269-7	68955-33-9	649-167-00-7	REFINERY GAS
273-270-2	68955-34-0	649-112-00-7	PETROLEUM GAS
273-271-8	68955-35-1	649-308-00-2	LOW BOILING POINT CAT-REFORMED NAPHTHA
273-272-3	68955-36-2	649-035-00-9	HEAVY FUEL OIL
273-314-0	68956-70-7	NONE	REFINERY RECLAIM SUBSTANCE
273-563-5	68989-88-8	649-168-00-2	REFINERY GAS
274-635-9	70514-12-4	NONE	USED OR RE-REFINED OIL
274-683-0	70592-76-6	649-036-00-4	HEAVY FUEL OIL
274-684-6	70592-77-7	649-037-00-X	HEAVY FUEL OIL
274-685-1	70592-78-8	649-038-00-5	HEAVY FUEL OIL
274-686-7	70592-79-9	NONE	PETROLEUM SUBSTANCE - UNSPECIFIED
276-735-8	72623-83-7	NONE	HIGHLY REFINED BASE OIL
276-736-3	72623-85-9	649-481-00-4	BASE OIL - UNSPECIFIED
276-737-9	72623-86-0	649-482-00-X	BASE OIL - UNSPECIFIED
276-738-4	72623-87-1	649-483-00-5	BASE OIL - UNSPECIFIED
278-011-7	74869-21-9	649-243-00-X	GREASE
278-012-2	74869-22-0	649-484-00-0	BASE OIL - UNSPECIFIED
285-095-9	85029-72-7	NONE	PETROLEUM WAX
285-098-5	85029-74-9	649-256-00-0	PETROLATUM
285-505-6	85116-53-6	649-443-00-7	CRACKED GAS OIL
285-507-7	85116-55-8	649-412-00-8	CRACKED KEROSINE
285-508-2	85116-57-0	649-426-00-4	KEROSINE - UNSPECIFIED
285-509-8	85116-58-1	649-309-00-8	LOW BOILING POINT CAT-REFORMED NAPHTHA
285-510-3	85116-59-2	649-377-00-9	LOW BOILING POINT NAPHTHA - UNSPECIFIED
285-511-9	85116-60-5	649-335-00-X	LOW BOILING POINT HYDROGEN TREATED NAPHTHA
285-512-4	85116-61-6	649-336-00-5	LOW BOILING POINT HYDROGEN TREATED NAPHTHA
285-555-9	85117-03-9	649-039-00-0	HEAVY FUEL OIL
289-220-8	86290-81-5	649-378-00-4	LOW BOILING POINT NAPHTHA - UNSPECIFIED
289-339-5	87741-01-3	649-113-00-2	PETROLEUM GAS
292-454-3	90622-53-0	649-242-00-4	GAS OIL - UNSPECIFIED (OTHER GAS OILS)
292-456-4	90622-55-2	649-114-00-8	PETROLEUM GAS
292-613-7	90640-91-8	649-485-00-6	BASE OIL - UNSPECIFIED
292-614-2	90640-92-9	649-486-00-1	BASE OIL - UNSPECIFIED
292-615-8	90640-93-0	649-231-00-4	GAS OIL - UNSPECIFIED (OTHER GAS OILS)
292-616-3	90640-94-1	649-487-00-7	BASE OIL - UNSPECIFIED
292-617-9	90640-95-2	649-488-00-2	BASE OIL - UNSPECIFIED
292-618-4	90640-96-3	649-489-00-8	BASE OIL - UNSPECIFIED
292-620-5	90640-97-4	649-490-00-3	BASE OIL - UNSPECIFIED
292-621-0	90640-98-5	649-413-00-3	CRACKED KEROSINE
292-631-5	90641-07-9	649-534-00-1	DISTILLATE AROMATIC EXTRACT (TREATED)
292-632-0	90641-08-0	649-535-00-7	DISTILLATE AROMATIC EXTRACT (TREATED)
292-633-6	90641-09-1	649-536-00-2	DISTILLATE AROMATIC EXTRACT (TREATED)
292-637-8	90641-13-7	649-414-00-9	CRACKED KEROSINE
292-640-4	90669-47-9	NONE	PETROLEUM WAX
292-655-6	90669-60-6	NONE	PETROLEUM SUBSTANCE - UNSPECIFIED
292-656-1	90669-74-2	649-491-00-9	BASE OIL - UNSPECIFIED
292-657-7	90669-75-3	649-040-00-6	HEAVY FUEL OIL
292-658-2	90669-76-4	649-041-00-1	HEAVY FUEL OIL
292-659-8	90669-77-5	649-245-00-0	SLACK WAX

EINECS	CAS No.	INDEX No.	GROUP (SHORT NAME)
292-660-3	90669-78-6	649-246-00-6	SLACK WAX
292-695-4	90989-39-2	NONE	LOW BOILING POINT NAPHTHA - UNSPECIFIED
292-698-0	90989-42-7	649-379-00-X	LOW BOILING POINT NAPHTHA - UNSPECIFIED
293-258-0	91052-94-7	NONE	USED OR RE-REFINED OIL
293-299-4	91053-35-9	NONE	PETROLEUM SUBSTANCE - UNSPECIFIED
294-454-9	91722-55-3	NONE	STRAIGHT RUN GAS OIL
294-799-5	91770-15-9	649-427-00-X	KEROSINE - UNSPECIFIED
294-843-3	91770-57-9	649-492-00-4	BASE OIL - UNSPECIFIED
295-279-0	91995-18-5	649-310-00-3	LOW BOILING POINT CAT-REFORMED NAPHTHA
295-284-8	91995-23-2	NONE	BITUMEN OR VACUUM RESIDUE
295-294-2	91995-34-5	649-232-00-X	GAS OIL - UNSPECIFIED (OTHER GAS OILS)
295-298-4	91995-38-9	649-380-00-5	LOW BOILING POINT NAPHTHA - UNSPECIFIED
295-300-3	91995-39-0	649-493-00-X	BASE OIL - UNSPECIFIED
295-301-9	91995-40-3	649-494-00-5	BASE OIL - UNSPECIFIED
295-302-4	91995-41-4	649-381-00-0	LOW BOILING POINT NAPHTHA - UNSPECIFIED
295-306-6	91995-45-8	649-495-00-0	BASE OIL - UNSPECIFIED
295-307-1	91995-46-9	NONE	PETROLEUM SUBSTANCE - UNSPECIFIED
295-311-3	91995-50-5	649-293-00-2	LOW BOILING POINT CAT-CRACKED NAPHTHA
295-315-5	91995-53-8	649-283-00-8	LOW BOILING POINT MODIFIED NAPHTHA
295-316-0	91995-54-9	649-496-00-6	BASE OIL - UNSPECIFIED
295-317-6	91995-55-0	NONE	PETROLEUM SUBSTANCE - UNSPECIFIED
295-330-7	91995-67-4	NONE	AROMATIC EXTRACT - UNSPECIFIED
295-331-2	91995-68-5	649-382-00-6	LOW BOILING POINT NAPHTHA - UNSPECIFIED
295-332-8	91995-70-9	NONE	RESIDUAL AROMATIC EXTRACT
295-333-3	91995-71-0	NONE	AROMATIC EXTRACT – UNSPECIFIED
295-334-9	91995-72-1	NONE	AROMATIC EXTRACT - UNSPECIFIED
295-335-4	91995-73-2	649-537-00-8	DISTILLATE AROMATIC EXTRACT (TREATED)
295-338-0	91995-75-4	649-538-00-3	DISTILLATE AROMATIC EXTRACT (TREATED)
295-339-6	91995-76-5	649-539-00-9	DISTILLATE AROMATIC EXTRACT (TREATED)
295-340-1	91995-77-6	649-540-00-4	DISTILLATE AROMATIC EXTRACT (TREATED)
295-341-7	91995-78-7	649-005-00-5	DISTILLATE AROMATIC EXTRACT
295-342-2	91995-79-8	649-541-00-X	DISTILLATE AROMATIC EXTRACT (TREATED)
295-394-6	92045-12-0	649-550-00-9	FOOTS OIL
295-396-7	92045-14-2	649-042-00-7	HEAVY FUEL OIL
295-397-2	92045-13-5	649-169-00-8	REFINERY GAS
295-398-8	92045-16-4	649-170-00-3	REFINERY GAS
295-399-3	92045-17-5	649-171-00-9	REFINERY GAS
295-400-7	92045-18-6	649-172-00-4	REFINERY GAS
295-401-2	92045-19-7	649-173-00-X	REFINERY GAS
295-402-8	92045-20-0	649-174-00-5	REFINERY GAS
295-404-9	92045-22-2	649-115-00-3	PETROLEUM GAS
295-405-4	92045-23-3	649-116-00-9	PETROLEUM GAS
295-407-5	92045-24-4	NONE	VACUUM GAS OIL
295-408-0	92045-26-6	NONE	VACUUM GAS OIL
295-409-6	92045-27-7	NONE	VACUUM GAS OIL
295-411-7	92045-29-9	649-444-00-2	CRACKED GAS OIL
295-416-4	92045-36-8	649-428-00-5	KEROSINE - UNSPECIFIED
295-418-5	92045-37-9	649-407-00-0	STRAIGHT RUN KEROSINE
295-421-1	92045-40-4	NONE	USED OR RE-REFINED OIL
295-422-7	92045-41-5	NONE	USED OR RE-REFINED OIL
295-423-2	92045-42-6	649-497-00-1	BASE OIL - UNSPECIFIED
295-424-8	92045-43-7	649-498-00-7	BASE OIL - UNSPECIFIED
295-425-3	92045-44-8	NONE	HIGHLY REFINED BASE OIL
295-426-9	92045-45-9	NONE	HIGHLY REFINED BASE OIL
295-430-0	92045-49-3	649-284-00-3	LOW BOILING POINT MODIFIED NAPHTHA
295-431-6	92045-50-6	649-294-00-8	LOW BOILING POINT CAT-CRACKED NAPHTHA
295-432-1	92045-51-7	649-337-00-0	LOW BOILING POINT HYDROGEN TREATED NAPHTHA
295-433-7	92045-52-8	649-338-00-6	LOW BOILING POINT HYDROGEN TREATED NAPHTHA
295-434-2	92045-53-9	649-383-00-1	LOW BOILING POINT NAPHTHA - UNSPECIFIED
295-436-3	92045-55-1	649-285-00-9	LOW BOILING POINT MODIFIED NAPHTHA
295-438-4	92045-57-3	649-339-00-1	LOW BOILING POINT HYDROGEN TREATED NAPHTHA
295-440-5	92045-58-4	649-286-00-4	LOW BOILING POINT MODIFIED NAPHTHA
295-441-0	92045-59-5	649-295-00-3	LOW BOILING POINT CAT-CRACKED NAPHTHA
295-442-6	92045-60-8	649-384-00-7	LOW BOILING POINT NAPHTHA - UNSPECIFIED
295-443-1	92045-61-9	649-340-00-7	LOW BOILING POINT HYDROGEN TREATED NAPHTHA
295-444-7	92045-62-0	649-385-00-2	LOW BOILING POINT NAPHTHA - UNSPECIFIED
295-445-2	92045-63-1	649-386-00-8	LOW BOILING POINT NAPHTHA - UNSPECIFIED

EINECS	CAS No.	INDEX No.	GROUP (SHORT NAME)
295-446-8	92045-64-2	649-287-00-X	LOW BOILING POINT MODIFIED NAPHTHA
295-447-3	92045-65-3	649-326-00-0	LOW BOILING POINT THERMALLY CRACKED NAPHTHA
295-448-9	92045-66-4	NONE	REFINERY RECLAIM SUBSTANCE
295-456-2	92045-74-4	NONE	PETROLEUM WAX
295-457-8	92045-75-5	NONE	PETROLEUM WAX
295-458-3	92045-76-6	NONE	PETROLEUM WAX
295-459-9	92045-77-7	649-257-00-6	PETROLATUM
295-463-0	92045-80-2	649-117-00-4	PETROLEUM GAS
295-499-7	92061-86-4	649-499-00-2	BASE OIL - UNSPECIFIED
295-511-0	92061-97-7	649-043-00-2	HEAVY FUEL OIL
295-513-1	92061-99-9	NONE	PETROLEUM SUBSTANCE - UNSPECIFIED
295-514-7	92062-00-5	649-445-00-8	CRACKED GAS OIL
295-516-8	92062-03-8	NONE	USED OR RE-REFINED OIL
295-517-3	92062-04-9	649-446-00-3	CRACKED GAS OIL
295-518-9	92062-05-0	NONE	BITUMEN OR VACUUM RESIDUE
295-521-5	92062-07-2	NONE	REFINERY RECLAIM SUBSTANCE
295-523-6	92062-09-4	649-247-00-1	SLACK WAX
295-524-1	92062-10-7	649-248-00-7	SLACK WAX
295-525-7	92062-11-8	649-249-00-2	SLACK WAX
295-526-2	92062-12-9	NONE	REFINERY RECLAIM SUBSTANCE
295-528-3	92062-14-1	NONE	STRAIGHT RUN GAS OIL
295-529-9	92062-15-2	649-341-00-2	LOW BOILING POINT HYDROGEN TREATED NAPHTHA
295-550-3	92062-35-6	NONE	HIGHLY REFINED BASE OIL
295-794-0	92128-94-4	649-296-00-9	LOW BOILING POINT CAT-CRACKED NAPHTHA
295-810-6	92129-09-4	649-500-00-6	BASE OIL – UNSPECIFIED
295-990-6	92201-59-7	649-044-00-8	HEAVY FUEL OIL
295-991-1	92201-60-0	649-447-00-9	CRACKED GAS OIL
296-028-8	92201-97-3	649-387-00-3	LOW BOILING POINT NAPHTHA - UNSPECIFIED
296-437-1	92704-08-0	649-542-00-5	DISTILLATE AROMATIC EXTRACT (TREATED)
296-468-0	92704-36-4	NONE	STRAIGHT RUN GAS OIL
296-903-4	93165-19-6	649-388-00-9	LOW BOILING POINT NAPHTHA - UNSPECIFIED
296-942-7	93165-55-0	649-342-00-8	LOW BOILING POINT HYDROGEN TREATED NAPHTHA
297-104-3	93334-30-6	NONE	USED OR RE-REFINED OIL
297-401-8	93571-75-6	649-311-00-9	LOW BOILING POINT CAT-REFORMED NAPHTHA
297-458-9	93572-29-3	649-312-00-4	LOW BOILING POINT CAT-REFORMED NAPHTHA
297-465-7	93572-35-1	649-313-00-X	LOW BOILING POINT CAT-REFORMED NAPHTHA
297-466-2	93572-36-2	649-314-00-5	LOW BOILING POINT CAT-REFORMED NAPHTHA
297-474-6	93572-43-1	649-501-00-1	BASE OIL - UNSPECIFIED
297-488-2	93572-57-7	NONE	REFINERY RECLAIM SUBSTANCE
297-827-4	93763-10-1	649-543-00-0	DISTILLATE AROMATIC EXTRACT (TREATED)
297-829-5	93763-11-2	649-544-00-6	DISTILLATE AROMATIC EXTRACT (TREATED)
297-852-0	93763-33-8	649-343-00-3	LOW BOILING POINT HYDROGEN TREATED NAPHTHA
297-853-6	93763-34-9	649-344-00-9	LOW BOILING POINT HYDROGEN TREATED NAPHTHA
297-854-1	93763-35-0	649-429-00-0	KEROSINE - UNSPECIFIED
297-857-8	93763-38-3	649-502-00-7	BASE OIL - UNSPECIFIED
297-905-8	93763-85-0	649-448-00-4	CRACKED GAS OIL
298-754-0	93821-66-0	649-045-00-3	HEAVY FUEL OIL
300-225-7	93924-31-3	649-175-00-0	FOOTS OIL
300-226-2	93924-32-4	649-176-00-6	FOOTS OIL
300-227-8	93924-33-5	649-233-00-5	GAS OIL - UNSPECIFIED (OTHER GAS OILS)
300-257-1	93924-61-9	649-503-00-2	BASE OIL - UNSPECIFIED
302-639-3	94114-03-1	649-389-00-4	LOW BOILING POINT NAPHTHA - UNSPECIFIED
302-656-6	94114-22-4	NONE	BITUMEN OR VACUUM RESIDUE
305-588-5	94733-08-1	649-504-00-8	BASE OIL - UNSPECIFIED
305-589-0	94733-09-2	649-505-00-3	BASE OIL - UNSPECIFIED
305-590-6	94733-10-5	NONE	AROMATIC EXTRACT - UNSPECIFIED
305-594-8	94733-15-0	649-506-00-9	BASE OIL - UNSPECIFIED
305-595-3	94733-16-1	649-507-00-4	BASE OIL - UNSPECIFIED
305-750-5	95009-23-7	649-390-00-X	LOW BOILING POINT NAPHTHA - UNSPECIFIED
305-971-7	95371-04-3	649-508-00-X	BASE OIL - UNSPECIFIED
305-972-2	95371-05-4	649-509-00-5	BASE OIL - UNSPECIFIED
305-974-3	95371-07-6	649-510-00-0	BASE OIL - UNSPECIFIED
305-975-9	95371-08-7	649-511-00-6	BASE OIL - UNSPECIFIED
306-004-1	95465-89-7	649-118-00-X	PETROLEUM GAS
307-010-7	97488-73-8	649-512-00-1	BASE OIL - UNSPECIFIED
307-011-2	97488-74-9	649-513-00-7	BASE OIL - UNSPECIFIED
307-012-8	97488-75-0	NONE	AROMATIC EXTRACT - UNSPECIFIED

EINECS	CAS No.	INDEX No.	GROUP (SHORT NAME)
307-033-2	97488-94-3	649-430-00-6	KEROSINE - UNSPECIFIED
307-034-8	97488-95-4	649-514-00-2	BASE OIL - UNSPECIFIED
307-035-3	97488-96-5	649-234-00-0	GAS OIL - UNSPECIFIED (OTHER GAS OILS)
307-045-8	97489-05-9	NONE	PETROLEUM WAX
307-659-6	97675-85-9	649-235-00-6	GAS OIL - UNSPECIFIED (OTHER GAS OILS)
307-660-1	97675-86-0	649-236-00-1	GAS OIL - UNSPECIFIED (OTHER GAS OILS)
307-661-7	97675-87-1	649-515-00-8	BASE OIL - UNSPECIFIED
307-662-2	97675-88-2	649-449-00-X	CRACKED GAS OIL (HYDROCRACKED GAS OIL)
307-750-0	97722-01-5	NONE	VACUUM GAS OIL
307-753-7	97722-04-8	649-006-00-0	DISTILLATE AROMATIC EXTRACT
307-754-2	97722-05-9	NONE	VACUUM GAS OIL
307-755-8	97722-06-0	649-516-00-3	BASE OIL - UNSPECIFIED
307-756-3	97722-07-1	NONE	VACUUM GAS OIL
307-757-9	97722-08-2	649-237-00-7	GAS OIL - UNSPECIFIED (OTHER GAS OILS)
307-758-4	97722-09-3	649-517-00-9	BASE OIL - UNSPECIFIED
307-760-5	97722-10-6	649-518-00-4	BASE OIL - UNSPECIFIED
307-769-4	97722-19-5	649-119-00-5	PETROLEUM GAS
308-126-0	97862-76-5	649-211-00-5	FOOTS OIL
308-127-6	97862-77-6	649-315-00-0	FOOTS OIL
308-128-1	97862-78-7	649-238-00-2	GAS OIL - UNSPECIFIED (OTHER GAS OILS)
308-131-8	97862-81-2	649-519-00-X	BASE OIL - UNSPECIFIED
308-132-3	97862-82-3	649-520-00-5	BASE OIL - UNSPECIFIED
308-133-9	97862-83-4	649-521-00-0	BASE OIL - UNSPECIFIED
308-140-7	97862-89-0	NONE	PETROLEUM WAX
308-141-2	97862-90-3	NONE	PETROLEUM WAX
308-142-8	97862-91-4	NONE	PETROLEUM WAX
308-143-3	97862-92-5	NONE	PETROLEUM WAX
308-144-9	97862-93-6	NONE	PETROLEUM WAX
308-145-4	97862-94-7	NONE	PETROLEUM WAX
308-147-5	97862-95-8	NONE	PETROLEUM WAX
308-148-0	97862-96-9	NONE	PETROLEUM WAX
308-149-6	97862-97-0	649-258-00-1	PETROLATUM
308-150-1	97862-98-1	649-259-00-7	PETROLATUM
308-155-9	97863-04-2	649-250-00-8	SLACK WAX
308-156-4	97863-05-3	649-251-00-3	SLACK WAX
308-158-5	97863-06-4	649-252-00-9	SLACK WAX
308-252-6	97926-35-7	NONE	PETROLEUM SUBSTANCE - UNSPECIFIED
308-261-5	97926-43-7	649-391-00-5	LOW BOILING POINT NAPHTHA - UNSPECIFIED
308-278-8	97926-59-5	649-450-00-5	CRACKED GAS OIL
308-287-7	97926-68-6	649-522-00-6	BASE OIL - UNSPECIFIED
308-289-8	97926-70-0	649-523-00-1	BASE OIL - UNSPECIFIED
308-290-3	97926-71-1	649-524-00-7	BASE OIL - UNSPECIFIED
308-527-0	98072-71-0	NONE	REFINERY RECLAIM SUBSTANCE
308-713-1	98219-46-6	649-392-00-0	LOW BOILING POINT NAPHTHA - UNSPECIFIED
308-714-7	98219-47-7	649-393-00-6	LOW BOILING POINT NAPHTHA - UNSPECIFIED
308-733-0	98219-64-8	649-046-00-9	HEAVY FUEL OIL
308-935-9	99035-68-4	NONE	USED OR RE-REFINED OIL
309-667-5	100683-97-4	649-239-00-8	GAS OIL - UNSPECIFIED (OTHER GAS OILS)
309-668-0	100683-98-5	649-240-00-3	GAS OIL - UNSPECIFIED (OTHER GAS OILS)
309-669-6	100683-99-6	649-241-00-9	GAS OIL - UNSPECIFIED (OTHER GAS OILS)
309-670-1	100684-00-2	NONE	AROMATIC EXTRACT - UNSPECIFIED
309-671-7	100684-01-3	NONE	AROMATIC EXTRACT - UNSPECIFIED
309-672-2	100684-02-4	649-545-00-1	DISTILLATE AROMATIC EXTRACT (TREATED)
309-673-8	100684-03-5	649-546-00-7	DISTILLATE AROMATIC EXTRACT (TREATED)
309-674-3	100684-04-6	649-547-00-2	DISTILLATE AROMATIC EXTRACT (TREATED)
309-675-9	100684-05-7	649-548-00-8	DISTILLATE AROMATIC EXTRACT (TREATED)
309-676-4	100684-06-8	NONE	AROMATIC EXTRACT - UNSPECIFIED
309-678-5	100684-07-9	NONE	AROMATIC EXTRACT - UNSPECIFIED
309-693-7	100684-22-8	NONE	VACUUM GAS OIL
309-694-2	100684-23-9	NONE	VACUUM GAS OIL
309-695-8	100684-24-0	NONE	STRAIGHT RUN GAS OIL
309-706-6	100684-33-1	649-260-00-2	PETROLATUM
309-710-8	100684-37-5	649-525-00-2	BASE OIL - UNSPECIFIED
309-711-3	100684-38-6	649-526-00-8	BASE OIL - UNSPECIFIED
309-712-9	100684-39-7	NONE	BITUMEN OR VACUUM RESIDUE
309-713-4	100684-40-0	NONE	BITUMEN OR VACUUM RESIDUE
309-723-9	100684-49-9	649-253-00-4	SLACK WAX

EINECS	CAS No.	INDEX No.	GROUP (SHORT NAME)
309-862-5	101316-56-7	649-394-00-1	LOW BOILING POINT NAPHTHA - UNSPECIFIED
309-863-0	101316-57-8	649-047-00-4	HEAVY FUEL OIL
309-864-6	101316-58-9	649-431-00-1	KEROSINE - UNSPECIFIED
309-865-1	101316-59-0	649-451-00-0	CRACKED GAS OIL
309-866-7	101316-61-4	649-415-00-4	CRACKED KEROSINE
309-870-9	101316-66-9	649-395-00-7	LOW BOILING POINT NAPHTHA - UNSPECIFIED
309-871-4	101316-67-0	649-288-00-5	LOW BOILING POINT MODIFIED NAPHTHA
309-874-0	101316-69-2	649-527-00-3	BASE OIL - UNSPECIFIED
309-875-6	101316-70-5	649-528-00-9	BASE OIL - UNSPECIFIED
309-876-1	101316-71-6	649-529-00-4	BASE OIL - UNSPECIFIED
309-877-7	101316-72-7	649-530-00-X	BASE OIL - UNSPECIFIED
309-878-2	101316-73-8	NONE	USED OR RE-REFINED OIL
309-879-8	101316-76-1	649-396-00-2	LOW BOILING POINT NAPHTHA - UNSPECIFIED
309-881-9	101316-80-7	649-417-00-5	CRACKED KEROSINE
309-882-4	101316-81-8	649-432-00-7	KEROSINE - UNSPECIFIED
309-884-5	101316-82-9	649-433-00-2	KEROSINE - UNSPECIFIED
309-938-8	101631-13-4	649-416-00-X	CRACKED KEROSINE
309-939-3	101631-14-5	649-452-00-6	CRACKED GAS OIL
309-940-9	101631-15-6	649-418-00-0	CRACKED KEROSINE
309-943-5	101631-18-9	NONE	REFINERY RECLAIM SUBSTANCE
309-944-0	101631-19-0	649-434-00-8	KEROSINE - UNSPECIFIED
309-945-6	101631-20-3	649-273-00-3	LOW BOILING POINT NAPHTHA
309-974-4	101794-97-2	649-297-00-4	LOW BOILING POINT CAT-CRACKED NAPHTHA
309-976-5	101795-01-1	649-397-00-8	LOW BOILING POINT NAPHTHA - UNSPECIFIED
309-987-5	101896-28-0	649-298-00-X	LOW BOILING POINT CAT-CRACKED NAPHTHA
310-012-0	102110-14-5	649-398-00-3	LOW BOILING POINT NAPHTHA - UNSPECIFIED
310-013-6	102110-15-6	649-399-00-9	LOW BOILING POINT NAPHTHA - UNSPECIFIED
310-057-6	102110-55-4	649-400-00-2	LOW BOILING POINT NAPHTHA - UNSPECIFIED

ANNEX III

SAFETY PHRASES

Extract from Directive 2001/59/EC (28th ATP of the Dangerous Substances Directive).

6. CHOICE OF SAFETY ADVICE PHRASES

6.1. **Introduction**

Safety advice phrases (S-phrases) shall be assigned to dangerous substances and preparations in accordance with the following general criteria. In addition, for certain preparations, the safety advice listed in Annex V to Directive 1999/45/EC is mandatory.

Whenever the manufacturer is mentioned in Chapter 6 it refers to the person responsible for placing the substance or preparation on the market.

6.2. **Safety phrases for substances and preparations**

S1 *Keep locked up*

— Applicability:

— very toxic, toxic and corrosive substances and preparations.

Note: Text continued on next page.

— Criteria for use:

— *obligatory* for those substances and preparations mentioned above if sold to the general public.

S2 *Keep out of the reach of children*

— Applicability:

— all dangerous substances and preparations.

— Criteria for use:

— *obligatory* for all dangerous substances and preparations sold to the general public, except for those only classified as dangerous for the environment.

S3 *Keep in a cool place*

— Applicability:

— organic peroxides,

— other dangerous substances and preparations having a boiling point of ≤ 40 °C.

— Criteria for use:

— *obligatory* for organic peroxides unless S47 is used,

— recommended for other dangerous substances and preparations having a boiling point of ≤ 40 °C.

S4 *Keep away from living quarters*

— Applicability:

— very toxic and toxic substances and preparations.

— Criteria for use:

— normally limited to very toxic and toxic substances and preparations when desirable to supplement S13; for example when there is an inhalation risk and the substance or preparation should be stored away from living quarters. The advice is not intended to preclude proper use of the substance or preparation in living quarters.

S5 *Keep contents under … (appropriate liquid to be specified by the manufacturer)*

— Applicability:

— spontaneously flammable solid substances and preparations.

— Criteria for use:

— normally limited to special cases, e.g. sodium, potassium or white phosphorous.

S6 *Keep under … (inert gas to be specified by the manufacturer)*

— Applicability:

— dangerous substances and preparations which must be kept under an inert atmosphere.

— Criteria for use:

— normally limited to special cases, e.g. certain organo-metallic compounds.

S7 *Keep container tightly closed*

— Applicability:

  — organic peroxides,

  — substances and preparations which can give off very toxic, toxic, harmful or extremely flammable gases,

  — substances and preparations which in contact with moisture give off extremely flammable gases,

  — highly flammable solids.

— Criteria for use:

  — *obligatory* for organic peroxides,

  — recommended for the other fields of application mentioned above.

S8 *Keep container dry*

— Applicability:

  — substances and preparations which may react violently with water,

  — substances and preparations which on contact with water liberate extremely flammable gases,

  — substances and preparations which on contact with water liberate very toxic or toxic gases.

— Criteria for use:

  — normally limited to the fields of application mentioned above when necessary to reinforce warnings given by R14, R15 in particular, and R29.

S9 *Keep container in a well-ventilated place*

— Applicability:

  — volatile substances and preparations which may give off very toxic, toxic or harmful vapours,

  — extremely flammable or highly flammable liquids and extremely flammable gases.

— Criteria for use:

  — recommended for volatile substances and preparations which may give off very toxic, toxic or harmful vapours,

  — recommended for extremely flammable or highly flammable liquids or extremely flammable gases.

S12 *Do not keep the container sealed*

— Applicability:

  — substances and preparations which will by giving off gases or vapours be liable to burst the container.

— Criteria for use:

  — normally limited to the special cases mentioned above.

S13 *Keep away from food, drink and animal feedingstuffs*

— Applicability:

  — very toxic, toxic and harmful substances and preparations.

— Criteria for use:

  — recommended when such substances and preparations are likely to be used by the general public.

S14 *Keep away from … (incompatible materials to be indicated by the manufacturer)*

— Applicability:

— organic peroxides.

— Criteria for use:

— *obligatory* for and normally limited to organic peroxides. However, may be useful in exceptional cases when incompatibility is likely to product a particular risk

S15 *Keep away from heat*

— Applicability:

— substances and preparations which may decompose or which may react spontaneously under the effect of heat.

— Criteria for use:

— normally limited to special cases, e.g. monomers, but not assigned if risk phrases R2, R3 and/or R5 have already been applied.

S16 *Keep away from sources of ignition — No smoking*

— Applicability:

— extremely flammable or highly flammable liquids and extremely flammable gases.

— Criteria for use:

— recommended for the substances and preparations mentioned above but not assigned if risk phrases R2, R3 and/or R5 have already been applied.

S17 *Keep away from combustible material*

— Applicability:

— substances and preparations which may form explosive or spontaneously flammable mixtures with combustible material.

— Criteria for use:

— available for use in special cases, e.g. to emphasise R8 and R9.

S18 *Handle and open container with care*

— Applicability:

— substances and preparations liable to produce an overpressure in the container,

— substances and preparations which may form explosive peroxides.

— Criteria for use:

— normally limited to the abovementioned cases when there is risk of damage to the eyes and/or when the substances and preparations are likely to be used by the general public.

S20 *When using do not eat or drink*

— Applicability:

— very toxic, toxic and corrosive substances and preparations.

— Criteria for use:

— normally limited to special cases (e.g. arsenic and arsenic compounds; fluoracetates) in particular when any of these are likely to be used by the general public.

S21 *When using do not smoke*

— Applicability:

— substances and preparations which produce toxic products on combustion.

— Criteria for use:

— normally limited to special cases (e.g. halogenated compounds).

S22 *Do not breathe dust*

— Applicability:

— all solid substances and preparations dangerous for health.

— Criteria for use:

— *obligatory* for those substances and preparations mentioned above to which R42 is assigned,

— recommended for those substances and preparations mentioned above which are supplied in the form of an inhalable dust and for which the health hazards following inhalation are not known.

S23 *Do not breathe gas/fumes/vapour/spray (appropriate wording to be specified by the manufacturer)*

— Applicability:

— all liquid or gaseous substances and preparations dangerous to health.

— Criteria for use:

— *obligatory* for those substances and preparations mentioned above to which R42 is assigned,

— *obligatory* for substances and preparations intended for use by spraying. Either S38 or S51 must be ascribed in addition,

— recommended when it is necessary to draw the attention of the user to inhalation risks not mentioned in the risk phrases which have to be ascribed.

S24 *Avoid contact with skin*

— Applicability:

— all substances and preparations dangerous for health.

— Criteria for use:

— *obligatory* for those substances and preparations to which R43 has been ascribed, unless S36 has also been ascribed,

— recommended when it is necessary to draw the attention of the user to skin contact risks not mentioned in the risk phrases (e.g. paresthesia) which have to be ascribed. However, may be used to emphasise such risk phrases.

S25 *Avoid contact with eyes*

— Applicability:

— all substances and preparations dangerous to health.

— Criteria for use:

— recommended when it is necessary to draw the attention of the user to eye contact risks not mentioned in the risk phrases which have to be applied. However, may be used to emphasise such risk phrases,

— recommended for substances ascribed R34, R35, R36 or R41 which are likely to be used by the general public.

S26 *In case of contact with eyes, rinse immediately with plenty of water and seek medical advice*

— Applicability:

— corrosive or irritant substances and preparations.

— Criteria for use:

— *obligatory* for corrosive substances and preparations and those to which R41 has already been ascribed,

— recommended for irritant substances and preparations to which the risk phrase R36 has already been ascribed.

S27 *Take off immediately all contaminated clothing*

— Applicability:

— very toxic, toxic or corrosive substances and preparations.

— Criteria for use:

— *obligatory* for very toxic substances and preparations to which R27 has been ascribed and which are likely to be used by the general public,

— recommended for very toxic substances and preparations to which R27 has been ascribed used in industry. However, this safety phrase should not be used if S36 has been ascribed,

— recommended for toxic substances and preparations to which R24 has been ascribed as well as corrosive substances and preparations which are likely to be used by the general public.

S28 *After contact with skin, wash immediately with plenty of … (to be specified by the manufacturer)*

— Applicability:

— very toxic, toxic or corrosive substances and preparations.

— Criteria for use:

— *obligatory* for very toxic substances and preparations,

— recommended for the other substances and preparations mentioned above, in particular when water is not the most appropriate rinsing fluid,

— recommended for corrosive substances and preparations which are likely to be used by the general public.

S29 *Do not empty into drains*

— Applicability:

— extremely or highly flammable liquids immiscible with water,

— very toxic and toxic substances and preparations,

— substances and preparations dangerous for the environment.

— Criteria for use:

— *obligatory* for substances and preparations dangerous for the environment and assigned the symbol 'N', which are likely to be used by the general public, unless this is the intended use,

— recommended for other substances and preparations mentioned above which are likely to be used by the general public, unless this is the intended use.

S30 *Never add water to this product*

— Applicability:

— substances and preparations which react violently with water.

— Criteria for use:

— normally limited to special cases (e.g. sulphuric acid) and may be used, as appropriate, to give the clearest possible information, either to emphasise R14 or as an alternative to R14.

S33 *Take precautionary measures against static discharges*

— Applicability:

— extremely or highly flammable substances and preparations.

— Criteria for use:

— recommended for substances and preparations used in industry which do not absorb moisture. Virtually never used for substances and preparations as placed on the market for use by the general public.

S35 *This material and its container must be disposed of in a safe way*

— Applicability:

— all dangerous substances and preparations.

— Criteria for use:

— recommended for substances and preparations where special guidance is needed to ensure proper disposal.

S36 *Wear suitable protective clothing*

— Applicability:

— organic peroxides,

— very toxic, toxic or harmful substances and preparations,

— corrosive substances and preparations.

— Criteria for use:

— *obligatory* for very toxic and corrosive substances and preparations,

— *obligatory* for those substances and preparations to which either R21 or R24 has been ascribed,

— *obligatory* for category 3 carcinogens, mutagens and substances toxic to reproduction unless the effects are produced solely by inhalation of the substance or preparation,

— *obligatory* for organic peroxides,

— recommended for toxic substances and preparations if the LD_{50} dermal value is unknown but the substance or preparation is likely to be toxic through skin contact,

— recommended for substances and preparations used in industry which are liable to damage health by prolonged exposure.

S37 *Wear suitable gloves*

— Applicability:

  — very toxic, toxic, harmful or corrosive substances and preparations,

  — organic peroxides,

  — substances and preparations irritating to the skin or causing sensitisation by skin contact.

— Criteria for use:

  — *obligatory* for very toxic and corrosive substances and preparations,

  — *obligatory* for those substances and preparations to which either R21, R24 or R43 has been ascribed,

  — *obligatory* for category 3 carcinogens, mutagens and substances toxic to reproduction unless the effects are produced solely by inhalation of the substances and preparations,

  — *obligatory* for organic peroxides,

  — recommended for toxic substances and preparations if the LD_{50} dermal value is unknown but the substance or preparation is likely to be harmful by skin contact,

  — recommended for substances and preparations irritating to the skin.

S38 *In case of insufficient ventilation, wear suitable respiratory equipment*

— Applicability:

  — very toxic or toxic substances and preparations.

— Criteria for use:

  — normally limited to special cases involving the use of very toxic or toxic substances and preparations in industry or in agriculture.

S39 *Wear eye/face protection*

— Applicability:

  — organic peroxides,

  — corrosive substances and preparations, including irritants which give rise to risk of serious damage to the eyes,

  — very toxic and toxic substances and preparations.

— Criteria for use:

  — *obligatory* for those substances and preparations to which R34, R35 or R41 have been ascribed,

  — *obligatory* for organic peroxides,

  — recommended when it is necessary to draw the attention of the user to eye contact risks not mentioned in the risk phrases which have to be ascribed,

  — normally limited to exceptional cases for very toxic and toxic substances and preparations, where there is a risk of splashing and they are likely to be easily absorbed by the skin.

S40 *To clean the floor and all objects contaminated by this material use … (to be specified by the manufacturer)*

— Applicability:

  — all dangerous substances and preparations.

— Criteria for use:

— normally limited to those dangerous substances and preparations for which water is not considered to be a suitable cleansing agent (e.g. where absorption by powdered material, dissolution by solvent etc. is necessary) and where it is important for health and/or safety reasons to provide a warning on the label.

S41 *In case of fire and/or explosion do not breathe fumes*

— Applicability:

— dangerous substances and preparations which on combustion give off very toxic or toxic gases.

— Criteria for use:

— normally limited to special cases.

S42 *During fumigation/spraying wear suitable respiratory equipment (appropriate wording to be specified by the manufacturer)*

— Applicability:

— substances and preparations intended for such use but which may endanger the health and safety of the user unless proper precautions are taken.

— Criteria for use:

— normally limited to special cases.

S43 *In case of fire use … (indicate in the space the precise type of fire-fighting equipment. If water increases the risk add: Never use water)*

— Applicability:

— extremely flammable, highly flammable and flammable substances and preparations.

— Criteria for use:

— *obligatory* for substances and preparations which, in contact with water or damp air, evolve extremely flammable gases,

— recommended for extremely flammable, highly flammable and flammable substances and preparations, particularly when they are immiscible with water.

S45 *In case of accident or if you feel unwell seek medical advice immediately (show the label where possible).*

— Applicability:

— very toxic substances and preparations,

— toxic and corrosive substances and preparations,

— substances and preparations causing sensitisation by inhalation.

— Criteria for use:

— *obligatory* for the substances and preparations mentioned above.

S46 *If swallowed, seek medical advice immediately and show this container or label*

— Applicability:

— all dangerous substances and preparations other than those which are very toxic, toxic, corrosive or dangerous to the environment.

— Criteria for use:

— *obligatory* for all dangerous substances and preparations mentioned above which are likely to be used by the general public, unless there is no reason to fear any danger from swallowing, particularly by children.

S47 *Keep at temperature not exceeding … °C (to be specified by the manufacturer)*

— Applicability:

— substances and preparations which become unstable at a certain temperature.

— Criteria for use:

— normally limited to special cases (e.g. certain organic peroxides).

S48 *Keep wetted with … (appropriate material to be specified by the manufacturer)*

— Applicability:

— substances and preparations which may become very sensitive to sparks, friction or impact if allowed to dry out.

— Criteria for use:

— normally limited to special cases, e.g. nitrocelluloses.

S49 *Keep only in the original container*

— Applicability:

— substances and preparations sensitive to catalytic decomposition.

— Criteria for use:

— substances and preparations sensitive to catalytic decomposition, e.g. certain organic peroxides.

S50 *Do not mix with … (to be specified by the manufacturer)*

— Applicability:

— substances and preparations which may react with the specified product to evolve very toxic or toxic gases,

— organic peroxides.

— Criteria for use:

— recommended for substances and preparations mentioned above which are likely to be used by the general public, when it is a better alternative to R31 or R32,

— *obligatory* with certain peroxides which may give violent reaction with accelerators or promoters.

S51 *Use only in well-ventilated areas*

— Applicability:

— substances and preparations likely to or intended to produce vapours, dusts, sprays, fumes, mists, etc. which give rise to inhalation risks or to a fire or explosion risk.

— Criteria for use:

— recommended when use of S38 would not be appropriate. Thus important when such substances and preparations are likely to be used by the general public.

S52 *Not recommended for interior use on large surface areas*

— Applicability:

  — volatile, very toxic, toxic and harmful substances and preparations containing them.

— Criteria for use:

  — recommended when damage to health is likely to be caused by prolonged exposure to these substances and preparations by reason of their volatilisation from large treated surfaces in the home or other enclosed places where persons congregate.

S53 *Avoid exposure — Obtain special instructions before use*

— Applicability:

  — substances and preparations that are carcinogenic, mutagenic and/or toxic to reproduction.

— Criteria for use:

  — *obligatory* for the abovementioned substances and preparations to which at least one of the following R-phrases has been assigned : R45, R46, R49, R60 or R61.

S56 *Dispose of this material and its container to hazardous or special waste collection point*

— Applicability:

  — all dangerous substances and preparations.

— Criteria for use:

  — recommended for all dangerous substances and preparations likely to be used by the general public for which special disposal is required.

S57 *Use appropriate containment to avoid environmental contamination*

— Applicability:

  — substances and preparations which have been assigned the symbol 'N'.

— Criteria for use:

  — normally limited to substances and preparations not likely to be used by the general public.

S59 *Refer to manufacturer for information on recovery/recycling*

— Applicability:

  — all dangerous substances and preparations.

— Criteria for use:

  — *obligatory* for substances and preparations dangerous for the ozone layer,

  — recommended for other substances and preparations for which recovery/recycling is recommended.

S60 *This material and its container must be disposed of as hazardous waste*

— Applicability:

  — all dangerous substances and preparations.

— Criteria for use:

  — recommended for substances and preparations not likely to be used by the general public and where S35 is not assigned.

S61 *Avoid release to the environment. Refer to special instructions/safety data sheet*

— Applicability:

  — substances and preparations dangerous for the environment.

— Criteria for use:

  — normally used for substances and preparations which have been assigned the symbol 'N',

  — recommended for all substances and preparations classified dangerous for the environment not covered above.

S62 *If swallowed, do not induce vomiting: seek medical advice immediately and show this container or label*

— Applicability:

  — substances and preparations classified as harmful with R65 in accordance with the criteria in section 3.2.3,

  — not applicable to substances and preparations which are placed on the market in aerosol containers (or in containers fitted with a sealed spray attachment), see sections 8 and 9.

— Criteria for use:

  — *obligatory* for substances and preparations mentioned above, if sold to, or likely to be used by the general public, except when S45 or S46 are obligatory,

  — recommended for the substances and preparations mentioned above when used in industry, except where S45 or S46 are obligatory.

S63 *In case of accident by inhalation: remove casualty to fresh air and keep at rest*

— Applicability:

  — very toxic and toxic substances and preparations (gases, vapours, particulates, volatile liquids),

  — substances and preparations causing respiratory sensitisation.

— Criteria for use:

  — *obligatory* for substances and preparations to which R26, R23 or R42 has been assigned which are likely to be used by the general public in a way which could result in inhalation.

S64 *If swallowed, rinse mouth with water (only if the person is conscious)*

— Applicability:

  — corrosive or irritant substances and preparations.

— Criteria for use:

  — recommended for the above substances and preparations which are likely to be used by the general public and where the above treatment is suitable.