INTERNATIONAL OIL POLLUTION COMPENSATION FUND

FONDS INTERNATIONAL D'INDEMNISATION POUR LES DOMMAGES DUS A LA POLLUTION PAR LES HYDROCARBURES

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DEFINITION OF THE TERM "PERSISTENT OIL" (Article I.5 of the CLC)

Note by the Director

1. The term "oil" is defined in Article I.5 of the CLC as "... any persistent oil such as crude oil, fuel oil, heavy diesel oil, lubricating oil and whale oil ...". Article 1.2 of the Fund Convention refers to this definition with the proviso that "... 'oil' shall be confined to persistent hydrocarbon mineral oils".

2. The word "persistent" does not have a scientific definition generally acknowledged for all purposes. This is why the question has arisen as to which oils are covered by the CLC and the Fund Convention and where to draw the line between "persistent" and "non-persistent" oils. This question has become relevant with respect to several incidents with which the IOPC Fund has to deal. Therefore, the Director has asked Mr. C. Walder, former Director of OCIMF, to prepare a non-technical guide to the nature and definition of persistent oil. This guide has also been discussed with experts of CRISTAL, ITOPF, OCIMF and the P & I Clubs, and some amendments, as suggested by these organizations, have been incorporated.

3. The Director is aware of the fact that the Assembly does not have the authority to adopt a definition of the term "oil" with the same binding effect as the Conventions

themselves. However, it would be of great assistance to the Director in carrying out his functions under the Fund Convention if the representatives of Contracting States could agree that the definition of "persistent oil" proposed in the annexed guide should be the one to be followed by the Director in dealing with claims made against the Fund.

4. The guide is herewith submitted at the Annex for consideration and possible adoption by the Assembly.

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ANNEX

A NON-TECHNICAL GUIDE TO THE NATURE AND DEFINITION OF PERSISTENT OIL

CONTENTS

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The assistance of the following institutions and the information available from their publications has made a major contribution to the preparation of this guide and is hereby gratefully acknowledged.

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FOREWORD

The International Convention on Civil Liability for Oil Pollution Damage 1969 holds the shipowner liable for pollution damage caused by persistent oil. However, the Convention does not define "persistent oil" and this has led to considerable difficulties in the application of the Civil Liability Convention. The same difficulty of application also arises with the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage 1971 where virtually the same definition is used.

This guide endeavours to set out, in non-technical language, some parameters which may explain the distinction between those oils which are persistent and those which are not, and thereby, facilitate the administration of the 1969 Civil Liability Convention and the 1971 Fund Convention.

GLOSSARY OF TERMS USED AND DEFINITIONS THEREOF

Aniline point

This is used as a parameter in the analysis of hydrocarbon mixtures. It is the minimum equilibrium temperature for equal volumes of aniline and the sample under test.

API gravity

This is a measure of the density of oil devised by the American Petroleum Institute. It is used world-wide for categorising crude and other oils. The API gravity of an oil decreases as its specific gravity increases.

The formula for determining API gravity from specific gravity is:

$$\text{API gravity} = \frac{141.5}{\text{specific gravity at } 60/60^{\circ}\text{F}} - 131.5$$

Aromatics
Aromatic content

Aromatics are ring chain hydrocarbons such as benzene, toluene and xylene and derivatives thereof. Because of their structure they are very stable, resist degradation and break down into the environment more slowly than straight chain paraffinic molecules.

The aromatic content of an oil is the percentage content by volume of aromatic hydrocarbons to the total.

Boiling range
Initial boiling point
Mid-point (or 50% point)
Final boiling point (or end point)

The boiling range of a particular cut or fraction is the temperature spread between initial and final boiling points.

Initial boiling point is the observed temperature at which the first drop of the material under test distils over into the receiving vessel after heating in the original receptacle and passing through a condenser.

Mid-point (or 50% point) is the temperature at which 50% by volume of the sample under test reaches the receiving vessel.

Final boiling point (or end point) is the temperature at which the last drop of the material under test evaporates from the original receptacle.

Calorific value

This is the amount of heat liberated when a fuel is burned completely under standard test conditions. Values are reported in calories per gram, megajoules per kilo (MJ/kilo) or, in some cases, as British thermal units per pound of fuel (BTUs/lb).

Cloud point

This is the temperature below which waxy crystals will form in an oil thereby impeding its flow through narrow orifices. This test is particularly critical in the case of automotive diesel where formation of wax crystals could block the flow of fuel to the injectors of a diesel engine, causing it to stall.

Cracking
Catalytic cracking
Steam cracking
Catalyst
Catalytic cycle oil

Cracking is a refining process whereby large molecules of hydrocarbon of a heavy or waxy feedstock can be broken up by heat and pressure or by heating in the presence of a catalyst to produce smaller molecules of lighter hydrocarbons. Cracking is used a great deal to upgrade heavy middle distillate material to more valuable materials particularly blending agents for motor gasoline.

Whilst cracking can take place by a combination of heat and pressure - usually referred to as thermal cracking - it is more usual and more efficient to carry out the process in the presence of a catalyst at lower temperature and pressure.

A catalyst is a material introduced into a process to aid or speed up a chemical reaction and which can be substantially recovered for re-use at the end of the process.

Steam cracking is a process involving the use of steam to maximise the production of olefins as the feedstock to a number of chemical processes.

Catalytic cycle oil is the material which is not cracked in the process and is neither a cracked gasoline fraction nor a cracked residuum. It is used as a component of No.2 heating oil and as a blendstock with bunker 'C' in the manufacture of intermediate grades of fuel oil.

Cut

This is a term applied to that portion of a crude oil or feedstock in a refining plant which is within a specific boiling range.

Diesel index

This is a formula calculation which is used as a measure of the ignition quality of gas/diesel oils. The formula is:

$$\text{diesel index} = \frac{\text{aniline point } (^{\circ}F) \text{ API gravity}}{100}$$

Distillation

This is the primary process in refining which heats the crude or feedstock to vaporise it for release into a fractionation tower where appropriate cuts or fractions are drawn off by controlling the temperature at different levels in the tower to the final boiling point of the cut required.

Feedstock

This is the term applied to the material fed into a refining process. It can be a crude oil or an intermediate process stock according to the purpose of the plant to which it is fed.

Fraction

This is the term applied to a part of a crude oil or feedstock within a specific boiling range. It is thus synonymous with "cut".

Heavy
Light

These terms are applied to oils and hydrocarbons generally to distinguish broadly between the volatile oils such as gasoline, kerosene and gas oils (light oils) and residual oils and waxy distillates (heavy oils). Agents for blending into finished oils are also on some occasions so categorised and the term may be used in a comparative sense in order to distinguish between certain oils, e.g. light cracked naphtha and heavy cracked naphtha. The light material will have a lower boiling range and specific gravity than the heavy material.

Hydrocarbon

The name given to the basic molecules which comprise petroleum, the basic stable hydrocarbon molecule, is methane (CH_4) which has one carbon atom and four hydrogen atoms, while other materials have different chemical formulae, eg. butane (C_4H_{10}).

Natural gas
Natural gas liquids
Condensate
Natural gasoline

Natural gas is gas issuing from the earth under pressure in certain localities often in association with the production of crude oil (referred to as "associated gas"). Natural gas is usually classified as "wet" or "dry" depending on the amount of gasoline constituents which can be recovered therefrom.

Natural gas liquids
Condensate

Liquids derived from natural gas production. The term usually encompasses LPG and natural gasoline but excludes LNG.

Natural gasoline is gasoline extracted from "wet" natural gas consisting of butane, pentane and heavier hydrocarbons. After stabilisation, natural gasoline is suitable for blending into motor gasoline.

Pour point

This is the temperature below which the material being tested will not flow if tilted in a sample container. It is used as a measure of ability to pump a fuel oil.

Residual
Residuum

General terms used to describe oils that are left over in the refining process and consist of heavy black oil used for heat and power generation. They are more specifically applied to that portion of a crude oil which remains in the pipe still after products have been removed which distil at or below 400°C (750°F).

Smoke point

This is the height of a flame in millimetres at which smoke first appears at the top of the flame when tested in a special lamp. The test is applied to kerosenes and burning oils.

Sulphur content

This is the amount of sulphur by weight present in a material expressed as a percentage of the material under test.

TEL and TML

Tetra ethyl lead and tetra methyl lead are the additives blended into gasoline to improve its octane (or anti-knock) rating.

Tonnes

This refers to the metric tonne of 1,000 kilogrammes.

Treating

This is the term applied to processes to which intermediate stocks are subjected to remove impurities or to bring them within the specification requirement of the products to which they will ultimately be blended.

Viscosity

This is a measure of the resistance to flow of an oil. There are several ways of reporting this and several tests to measure it. The Redwood and Saybolt tests report in seconds the time required for a measured sample at a given temperature to pass through an orifice of a predetermined size by gravity into a receiving vessel.

Kinematic viscosity is recorded in centistokes as recorded by test in an instrument called an ubbeometer.

NATURAL MECHANISMS WHICH AFFECT SPILLED OIL

When, for any reason, oil is spilled on the sea, a number of natural mechanisms come into force which change the characteristics of the oil and these are covered in this section. An understanding of these mechanisms is essential in order to differentiate between persistent and non-persistent oils.

The effect of nature on spilled oil is generally referred to as "weathering" and occurs as a result of a number of different natural processes, more than one of which can operate at the same time. The major natural effects are:

Spreading

Except for certain heavy residual fuel oils in very cold conditions, and any crude oils or fuel oils with a specific gravity greater than one, spilled oil will spread rapidly over the surface of the sea. The film thus formed will move in relation to current and tide and to a lesser extent is affected by wind. The depth of the film of oil on open water will decrease rapidly as the oil moves from the discharge point. Most crude oils will achieve a film thickness of about one millimetre shortly after discharge and will be no more than 0.3 millimetres in thickness after ten or twelve hours on open sea. Ultimately it will form a monomolecular layer which appears as a silvery sheen.

Evaporation

This is the most significant mechanism which changes the characteristics of spilled oil. Most crude oils will lose up to 50% of their volume within the first 24 hours following release. Lighter products, such as motor gasoline, will normally disappear completely within a matter of hours and kerosenes and gas oils have been shown to be untraceable within 24 hours of release into open sea. When trapped in estuarine areas and mud-flats, they may take somewhat longer to disperse entirely.

Dispersion

This involves the assimilation of small particles of oil into the water column. The rate of assimilation will vary with the composition of the oil involved and the weather and sea conditions. In moderate sea conditions thin films of oil are speedily incorporated into the upper layers of the sea and this process is speeded up in rougher weather.

Solution

This is of minor importance in comparison with other natural effects since most petroleum hydrocarbons have a low solubility in water. It is applicable only to lighter fractions of oil, some of which may be absorbed into the water almost immediately after discharge and rapidly disappear from the water surface.

Emulsification

This is the major problem for those who must endeavour to control and remove oil from the sea following a spill. This is particularly so after the first 12 hours or so following release, since emulsification combined with evaporation increases the likelihood of the remaining oil to form a stable "water-in-oil" emulsion often referred to as "chocolate mousse" which is unpumpable and extremely difficult to handle. Such emulsions can contain up to 75-80% water, are very stable, and therefore persist for quite long periods but will eventually break down leaving a tarry deposit.

Photo-oxidation

This is the effect of sunlight on spilled oil which may cause chemical changes in the oil or some of its constituents. It is believed to be responsible for bringing other processes referred to above into play more effectively and thus it contributes to removing oil from the sea.

Biodegradation

This results from bacterial action and is an important factor in ultimately removing oil from the sea. It acts together with other factors such as spreading and dispersion and helps to speed up the processes. Factors favourable to biodegradation are the extent of surface area of oil exposed and the availability of bacteria and certain nutrients which are required to sustain growth.

WHAT IS PERSISTENT OIL?

As its title implies, it was the intention of those who so described it to restrict the term to those residual hydrocarbons which were not amenable to rapid disappearance due to natural forces.

Thus it is that the definition of "oil" in the International Convention on Civil Liability for Oil Pollution Damage 1969 (CLC) reads:

> "'Oil' means any persistent oil such as crude oil, fuel oil, heavy diesel oil, lubricating oil and whale oil, whether carried on board a ship as cargo or in the bunkers of such a ship".

The definition in the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage 1971 (Fund Convention) is almost the same, except that whale oil is excluded, the precise wording being:

> "'Oil' (shall) ... have the same meaning as in Article I of the Liability Convention provided however that for the purposes of these terms 'oil' shall be confined to persistent hydrocarbon mineral oils".

The preparation of both these Conventions followed the first major pollution from a tanker, the TORREY CANYON, in March 1967, when virtually its entire cargo of 116,000 tonnes of crude oil was released into the sea off the Scilly Isles. This catastrophe emphasised the magnitude of pollution which could result from a single accident involving a volume of oil which was not easily capable of being absorbed by natural forces and which caused damage to beaches and in-shore fishing. Prior to this accident most spills had been relatively small or had involved light fractions of hydrocarbons which had been dealt with mainly by nature.

The legislators at the time of the 1969 Liability Convention recognised the danger of listing specific oils as those which were persistent. The main reasons for their not so doing were:

(i) Different nomenclature for the same hydrocarbon oils in different parts of the world would lead to confusion and inequitable treatment.

(ii) Intermediate products and process stocks change their name and make-up quite frequently and new stocks appear at regular intervals.

(iii) Crude oils are sold singly or in mixtures and are frequently named from the fields or regions from which produced; this also causes confusion.

(iv) Any oils not specifically listed would be excluded from coverage by the Conventions and would require an amendment of the Conventions and its ratification before any such oil could be included.

In an endeavour, therefore, to produce a definition which would be easily understood by those who were not oil experts, and which would encompass the variety of different terminologies and the many intermediate oils, the legislators produced a definition which included generic descriptions of the major persistent oils and supplemented it with the phrase "such as", in order not to exclude any obviously persistent oil which had not been specifically named.

The inclusion of these two words may have resolved one problem but it has created another by not stating which oils among those not specifically mentioned in this definition are covered by the Conventions.

This therefore poses the question as to whether there is a better or more precise way of defining what consitutes a persistent oil. To do so requires an elementary knowledge of the chemistry of oil and a look at how the oil industry itself deals with the problem.

IS THERE A MORE PRECISE WAY OF DEFINING PERSISTENT OIL?

85% of oil moving in international trade is crude oil. Its definition (for the purposes of "contributing oil") contained in Article 1.3(a) of the 1971 Fund Convention is concise and complete, and is the same as that generally used by industry.

> "'Crude oil' means any liquid hydrocarbon mixture occurring naturally in the earth whether or not treated to render it suitable for transportation. It also includes crude oils from which certain distillate fractions have been removed (sometimes referred to as 'topped crudes') or to which certain distillate fractions have been added (sometimes referred to as 'spiked' or 'reconstituted' crudes)."

It should be noted that natural gas liquids, condensate, casinghead and natural gasoline which are produced as gases are not crude oil. They are light hydrocarbons which condense from gas emanating from gas or oil wells and are usually separated out in a treating or stabilising plant. After treatment they are blended into gasoline or are used as feedstock to chemical plants.

These materials are highly volatile and are not persistent.

Crude oil is a mixture of hydrocarbons ranging from methane to bitumen. The lighter fractions which evaporate easily are not persistent whereas the heavier residual fractions with high boiling ranges are. All crude oils should therefore be regarded as persistent.

The lightest fractions in crude oil are: methane, ethane, propane and butane. These materials are gaseous at ambient temperatures in most parts of the world unless kept under pressure or refrigerated.

Gasoline fractions will normally be material with a final boiling point below 205°C (400°F). Kerosene fractions

are likely to have a boiling range of 150°C to 300°C (300°F to 575°F). Gas oil, auto diesel and heating oil fractions will probably have a boiling range of 175°C to 400°C (350°F to 750°F).

It is worthy of note that the gas oil/heating oil component varies widely in composition and final boiling point dependent upon the area in which it is refined, the characteristics of the crude from which it is manufactured, the eventual use and location of that use. The most significant differences are probably between No.2 heating oil emanating from many US Gulf refineries which will have a high proportion of catalytic cycle oil, low diesel index, low pour point and a final boiling point around 345°C (650°F), which is used for central heating and must be capable of being distributed in winter in the very cold weather experienced in the New England States of the USA, as compared to a gas oil manufactured in Europe from the lighter Middle East and North Sea crudes, which will be a straight run distillate from a primary distillation unit, with a much higher diesel index and a final boiling point which may be as high as 400°C (750°F). It is used for a variety of end-uses and has a pour point low enough to permit distribution in a European winter.

Beyond a final boiling point of approx. 400°C (750°F) come the residual-containing fractions such as marine diesel oils, lubricating oil feedstocks, catalytic cracking feedstock, fuel oils and bitumens.

The lighter fractions, i.e. gasolines, kerosenes and gas oils, are not normally regarded by industry as persistent. They are light in colour, low in viscosity and contain no residue fractions. For this reason they are classified as "clean" or "white" oils, and are usually transported by different vessels from those used for crude or "dirty" or "black" products. Experience and field tests have demonstrated conclusively that in open sea conditions "clean" oils show no trace a short time after spillage.

The most significant test in this regard was that carried out by the Warren Spring Laboratory of the Government of the United Kingdom in early 1973 and reported to IMCO as PCMP/4/33. In these tests, gasoline was discharged at the rate of 30 cubic metres per mile and heavy gas oil at 50 cubic metres per mile. No discernible trace of the gasoline could be found either on the surface or in the water column after one hour. The discharge of heavy gas oil showed only trace indications after two and a half hours with a concentration of 0.5 parts per million in the sub-surface layers.

Tests on other light products, including a number which were high in aromatic content (claimed by some to be a persistent light fraction), were subsequently carried out off Massachusetts by the Woods Hole Laboratory and these tests substantially confirmed the findings of the earlier studies.

The tests confirmed the industry's long-held view that a logical definition of persistent and non-persistent oils was that used for shipping oil, i.e. "clean" and "dirty".

"Clean" oils comprise gasolines, kerosenes and gas oils, and blend stocks for these products which are non-persistent.

"Dirty" oils comprise marine diesels, fuel oils, lubricating oils and crude oils which are classed as persistent and contain residual fractions.

At the time of the 1973 Diplomatic Conference which produced the International Convention for the Prevention of Pollution from Ships (MARPOL), the question of persistent and non-persistent oils was again discussed in detail, and a number of possible definitions were put forward.

After most of the proposals were discarded on the grounds of being too imprecise, the most promising solution seemed to be one which accurately defined non-persistent oils leaving everything else to be classed as persistent. The definition proposed for non-persistent oil was:

> "Oil which consists wholly of distillate fractions and of which more than 50% by volume distils at 340°C when tested by the ASTM Method D 86/78".

By this definition all crude oils, residual fuel oils, blended (residual-containing) diesel oils, lube oils and waxy distillates would automatically fall into the category of "persistent oil".

This definition was not proceeded with as the Conference decided not to differentiate between persistent and non-persistent oils for the control and discharge purposes of the 1973 MARPOL Convention. However, it remains probably the most precise method of drawing an accurate dividing line between persistent and non-persistent oil, which could satisfy both the lawyers and technical experts and which would be simple to ascertain as a matter of fact.

In order to clarify the point at which the determination should take place, it might be desirable to insert the words "at the time of shipment" after the word "which" in the first line.

Also, to prevent any argument as to what constitutes a "distillate" it might be preferable to refer to "non-residual fractions".

Thus, it is possible to define those oils which are covered by the Convention in the following terms:

> "All oils which are not within the category of 'non-persistent oil' as defined shall be regarded as 'persistent oil'. 'Non-persistent oil' is oil which, at the time of shipment, consists wholly of non-residual fractions and of which more than 50% by volume distils at a temperature of 340°C when tested by the ASTM Method D 86/78 or any subsequent revision thereof".

Whilst terms such as "distillate" and "residual" are commonly used and understood within industry, it may be desirable to formulate a definition of "non-persistent oil" which is expressed solely in terms of standard test methods. In this case the definition would read:

"'non-persistent oil' is oil which, at the time of shipment, consists of hydrocarbon fractions,

(a) more than 50% of which, by volume, distils at a temperature of 340°C (645°F),

and

(b) the temperature at which 95% distils does not exceed 400°C (750°F),

when tested by the ASTM Method D 86/78 or any subsequent revision thereof".

PETROLEUM PRODUCTS MOVED BY SEA

There follows a list of the major petroleum products which are moved by sea. The listing starts with the lightest (most volatile) products and continues through to the heavier residual products. A simple tabulation at the end divides the products into non-persistent and persistent categories.

Methane & Ethane

These form the main constituents of liquified natural gas (LNG) which is transported in special ships at temperatures around -260°F. At this temperature the gas is in liquid form without pressurisation. Since LNG would evaporate rapidly in the event of a spill it is not persistent and is not covered by CLC or Fund Convention.

Propane & Butane

These materials, generically referred to as LPG, are gaseous at normal atmospheric pressure and ambient temperature. For transportation they are either refrigerated or pressurised to convert them to liquids. Special ships are required for transport in bulk. LPG is also shipped in cylinders under pressure by normal transport. As with methane, these products evaporate rapidly if spilled and are not persistent.

Aviation Gasolines

As the name suggests, these materials are used for fuel in piston-engined aircraft. Most aviation gasolines contain lead (either as TEL or TML) and therefore are dyed, the colour indicating the octane number. Aviation gasoline grades are differentiated by their octane number which is quoted thus: Avgas 100/130. This refers to an octane rating of 100 on lean mixture and an octane rating of 130 on rich mixture. Aviation gasolines are volatile and evaporate quickly if exposed to air. They are not persistent.

Motor Gasolines

In most countries the majority of motor gasolines contain lead (as TEL or TML) to a specified maximum per litre or gallon. However, in recent years some authorities have required cars to be fitted with a catalytic converter on the vehicle exhaust system to reduce atmospheric emissions. Such cars require unleaded gasoline (sometimes referred to as "clear"), as lead in gasoline will gradually clog the catalyst and render it ineffective. All leaded gasolines are dyed, each grade being dyed a different colour. Gasolines are normally differentiated by their research method octane number, but occasionally gasoline may be quoted as X octane (MM) or motor method. The motor method gives a significantly lower octane number than the research rating.

Motor gasoline is a volatile substance and will evaporate quickly if exposed to air. For this reason it is not a persistent oil being untraceable in water after an hour or so. The possible danger in the case of gasoline spillage is that of fire and explosion if the vapours from its evaporation are exposed to an ignition source prior to dispersion.

White Spirit

This is a special product variously known as turpentine substitute, paint and varnish makers naphtha and a number of trade names. It is a product in the heavier gasoline range (it has a higher flashpoint than normal gasolines) but it is volatile when exposed to air and is not persistent.

Kerosenes

There are primarily two grades of kerosene in general domestic use. These are:

Premium kerosene used for lighting and for flue-less space heaters. Such material is highly refined and will sustain a brightly burning flame without soot or smoke. It also has a very low sulphur content which permits its use in flue-less space heaters.

Regular kerosene is used as a fuel for central heating in non-pressure jet burners, as a cooking fuel in many of the less developed countries and to light lamps in these areas. It has the same basic characteristics as premium kerosene, but has not been subjected to the additional treatment to increase smoke point and reduce sulphur content.

Tractor kerosene, otherwise referred to as vaporising oil or tractor vaporising oil (TVO), is a light aromatic kerosene produced as a fuel for farm tractors and similar machinery. Since most such equipment is now diesel-powered this grade is rapidly disappearing from the market.

Kerosenes - Aviation

Aviation kerosene or Avtur, Jet 1A, Turbo 2494, is basically a regular kerosene but has to meet certain exacting tests in the specification to be suitable for jet aircraft engines. In order to pass these, it may be necessary to subject regular kerosene to further treating processes.

Wide cut turbo fuel or Avtag, is a material used to fuel jet engines but is primarily, if not exclusively, used in military aircraft. As its name implies, it is manufactured by taking the heavier (higher boiling point) fractions from the gasoline cut and putting it into the kerosene fraction. This results in a larger yield of turbine fuel from a barrel of crude but it is not used by commercial airlines due to its greater flammability. Kerosene fuels (Avtur) have a flashpoint in excess of 38°C (100°F).

No.1 fuel oil is a kerosene oil "intended for vaporising pot type burners". It is the basic specification issued by the American Society for Testing and Materials (ASTM) under designation D 396.

Kerosenes, while less volatile than gasoline, evaporate and disappear quickly if spilled at sea due to the combined action of natural forces referred to earlier and are not persistent.

Gas Oils; Heating Oils; Automotive Diesel; No.2 Fuel

The middle distillate fraction from crude oil is known by a wide variety of names, usually associated with its end use. Thus:

Gas oil, which has become in some areas a generic term for middle distillates, was originally used in a process of gas enrichment whereby town gas supplies of insufficient calorific value were brought up to specification by blending it with vaporised gas oil.

Heating oil, as its name implies, is used in domestic heating or small industrial units using pressure (or gun) type burners.

Automotive diesel is a premium low sulphur,high quality material manufactured to a rigid specification for use in the diesel engines of cars and lorries. It has very low sulphur content and a low cloud point.

No.2 fuel is a standard specification for "general purpose domestic heating" issued by the American Society for Testing and Materials (ASTM) as specification D 396.

Gas oils, when spilled on open sea, are rapidly dispersed by the mechanisms referred to earlier herein and are not regarded as persistent.

Marine Diesel Oil

This is a heavy distillate or a mixture of light distillate and residual used mainly in ships' diesel engines. At present it is used, in particular, in auxiliary equipment or when vessels are in manoeuvring condition in or near port, since most modern slow speed diesel engines use heavier grades of residual for open sea operations. Marine diesel is regarded as persistent due to the inclusion of some residual fractions in this material.

No.4 Fuel

This is a similar material with a specification issued by ASTM as part of specification D 396.

Lubricating Oils

There are many hundreds of lubricating oils manufactured, since in industry lubricating oils are "tailor-made" for specific processes or industries. The generic term "lubricating oil" covers such widely varying materials as, for example:

Medicinal and Cosmetic Oils
Hydraulic Oils
Transformer Oils
Rust Preventatives
Refrigerating Oils
Quench Oils
Cutting Oils
Roll Oils
Synthetic Lubricants for jet engines
Brick and Concrete Mould Oils
Automotive Lubricants
Marine Diesel Lubricants,

to name but a few of the more important usages.

Most lubricants transported in bulk by sea are "blend stocks" - i.e. basic grades which are subsequently blended to make the multiplicity of finished grades referred to above.

Lubricating oils, because of their high added value and to prevent the slightest contamination, are usually transported in specialist vessels. Since the total volume of lubricants used (in comparison with total oil usage) is small, shipments of luboils are mainly in handy-size vessels or smaller. However, if spilled on open sea, lubricating oils are persistent.

Residual Fuel Oils

As the name implies, these are the grades of oil remaining after the lighter materials mentioned earlier have been distilled from crude oil. They are used for burning under boilers to generate heat or power, in heavy diesel engines at sea and in stationary engines ashore.

Whilst there are many grades of fuel oil which may be specified for particular uses, the three predominant grades are:

Light Fuel, No.5 Fuel Oil (Light)

This grade is a low viscosity fuel (150 - 300°SSU @ 100°F) which can be handled without heating, except in very cold climates.

Medium Fuel, No.5 Fuel Oil (Heavy) Heavy Fuel

This is a medium viscosity fuel (350-750°SSU @ 100°F) which requires moderate preheating for burning and in cold climates may require heating for pumping and handling.

Bunker "C", No.6 Fuel, Heavy Fuel Oil, Marine Fuel

This is the heaviest grade marketed and is the largest in volume movement. It has a viscosity range of 900-9,000°SSU @ 100°F or 45-300°SSF @ 122°F. In addition to being burned "as is", it is common practice to blend this material with marine diesel, heavy gas oil or catalytic cycle oil to produce light or medium fuel oils (No.5 fuel) or specialist grades, particularly for heavy marine diesel engines.

Another specialist grade of fuel oil which is manufactured as such, and is transported by sea, is Navy Special or USNS. This is a high quality premium fuel with low viscosity, low pour point and high calorific value, used by the US Navy.

All residual fuel oils are persistent.

Bitumen, Asphalt

This is the heaviest of all materials made from crude oil and in its normal state is solid at ambient temperatures. Many grades of bitumen have a specific gravity greater than one. Thus, in the event of its release into the sea, bitumen would solidify and sink or appear as lumps (similar to coal) and would be easily collectable.

Because of the need to transport bitumen at high temperature, it is only carried in specially constructed vessels and in small quantities.

Bitumens are categorised into three types:

Straight or Penetration Bitumen
Oxidised Bitumen
Cutback Bitumen, Road Oils and Emulsions.

This latter type of bitumen is a blend of bitumen with a solvent - usually a kerosene or creosote (and sometimes including an emulsifying agent) - which is liquid and is used for road spraying operations.

Bitumen is persistent in that it will resist breakdowns and dispersion by natural forces. However, penetration and oxidised grades of bitumen if spilled at sea would not present as difficult a pollution clean-up problem as residual fuels since it would be collected in the same manner as is used for normal beach cleaning.

If, however, cutback bitumens are released into the sea, some pollution may result, the extent of this depending on the specification of the material released.

Process Oils, Intermediates, Blend Stocks

It is not uncommon in the oil industry to move oils, which have been subjected to primary distillation and/or measures of treatment, by sea from one location to another. Also, it is common practice to move blend stocks, which are not in themselves finished products, to a location close to consumption where blending to the market requirement takes place. This is particularly the case with lubricating oils, residual fuel oils and motor gasolines.

For example, the feedstock for a catalytic cracking plant (cat. feedstock) may come from more than one primary distillation unit situated in different geographical locations. This material is usually a heavy distillate containing some residual or waxy fractions.

Similarly, catalytic cycle oil (the material which is not cracked in the process and is not a cracked residual) may be shipped to other locations as a blend stock to cut back bunker "C" to lighter grades of fuel oil. This material,

which has many of the characteristics of a gas oil, can be a major component in No.2 heating oil from certain areas, particularly those which have a high gasoline/distillate demand, such as those in the US Gulf. It is this material which has caused some environmentalists to try to widen the original definition of "persistent".

Following the "West Falmouth Spill" in September 1969, where No.2 heating oil containing a high proportion of cat. cycle oil was trapped in marsh sediments, a research study into its effect on the local ecology stated that the aromatic fractions present in cat. cycle oil resulted in persistent toxicity to benthic species. However, the findings of the West Falmouth Spill have been challenged by other scientists as being specific to those particular circumstances and not capable of extrapolation to other middle distillates or even to other cargoes of No.2 heating oil from different sources.

Feedstock for catalytic cracking plants (cat. feedstock) is a persistent oil in normal circumstances. However, there have been instances where, due to the paramount need to meet high gasoline demand, marketable gas oils have been shipped as cat. feedstock and used for that purpose. There are a number of locations where import of process stocks is permitted but where the import of finished products (gas oil) is not allowed or has very restrictive rules on its import.

The adoption of the definition proposed earlier would cover such cases.

Catalytic cycle oil should not normally be regarded as persistent but its make-up can vary considerably depending on the type of crude from which it is cut and the processes to which it has been subjected. Again the definition proposed would be determinative.

Aromatic tar is an intermediate which is carried by sea. Its main use is as a feedstock to plants making carbon black and is a highly persistent oil which should be removed from

the sea if possible, if it threatens coastlines or in-shore fisheries.

Steam cracker feed is a heavy gasoline/distillate material which is fed to a steam cracking process for the production of olefins for chemical manufacturing processes. It is a comparatively volatile material and is not persistent.

Light cracked naphtha
Heavy cracked naphtha
Steam cracked naphtha
Reformate, platformate

These, and many others, are gasoline blending stocks and all have the same characteristics as gasoline in that they are volatile and are non-persistent.

There are a multiplicity of process stocks which may be moved from one refinery to another for blending, to maximise efficiency and to balance yield with market demand. The names given to these process and blending stocks vary from area to area and from refinery to refinery. The blendstocks themselves change in constitution according to the plants which are used to produce them. It is for this reason that it would be impossible to produce a globally comprehensive list of all materials shipped by sea and keep it completely up to date. It is for this reason that the proposed definition, which would enable a clear delineation between persistent and non-persistent oil, is suggested.

FINISHED PRODUCTS

NON-PERSISTENT

Gases

- liquified natural gas (LNG) methane, ethane
- liquified petroleum gas (LPG) propane, butane

Gasolines

- aviation gasoline (AVGAS) - various grades by octane no.
- motor gasoline (MOGAS) - various grades by octane no.

White spirit (turpentine substitute, paint and varnish makers naphtha)

Kerosene

- Domestic
  - premium kerosene
  - regular kerosene
- Tractor kerosene (tractor vaporising oil)
- Aviation
  - Avtur, Jet 1A, turbo 2494
  - Avtag (wide cut turbo fuel)
- No. 1 fuel - basic ASTM specification

Distillate

- gas oil - various grades by diesel index
- heating oil
- automotive diesel - various grades by sulphur content
- No.2 fuel - basic ASTM specification

FINISHED PRODUCTS

PERSISTENT

- Marine diesel oil
- No.4 fuel - basic ASTM specification
- Lubricating oils
  - automotive - various grades by viscosity index (VI) or SAE rating
  - industrial - various grades by end use

- aviation - various grades by viscosity index
  - synthetic lubricants for jet engines
- marine - various grades by end use

- Residual fuels
  - navy special fuel oil
  - light fuel oil
  - No.5 fuel oil (light) - basic ASTM specification
  - medium fuel oil
  - No.5 fuel oil (heavy) - basic ASTM specification
  - bunker 'C'
  - heavy fuel oil
  - marine fuel oil
  - No.6 fuel oil - basic ASTM specification
  - blended fuel oils by viscosity and/or sulphur content
- Bitumen; asphalt
  - penetration grades (straight)
  - oxidised grades (oxidised)
  - cutback grades (road oils, emulsions)

Since there are many hundreds of intermediate products with a multiplicity of names, the following should be regarded only as an indicative list of the more common stocks.

INTERMEDIATE OILS, PROCESS STOCKS

NON-PERSISTENT

- Gasoline blending components
  - casinghead, natural gas liquids condensate and natural gasoline
  - straight run naphtha
  - light cracked naphtha
  - heavy cracked naphtha
  - platformate
  - reformate
  - steam cracked naphtha
  - polymers
  - isomers
  - alkylates

- Catalytic cycle oil
- Reformer feed
- Gas oil blend stocks

PERSISTENT

- Aromatic tar
- Catalytic cracker feedstocks
- Lubricating oil blend stocks
- Fuel oil blend stocks