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Concawe Investigation of the value of spectral data for the identification of petroleum UVCB substances

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Investigation of the value of spectral data for the identification of petroleum UVCB substances

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ABSTRACT

This report provides further information on the value of spectral data generated from the Concawe Analytical Program, and provides scientific justification that spectral data provides no additional composition information to that obtained by the other techniques recommended to registrants.

KEYWORDS

UVCB, petroleum substance, spectral data, Ultra-violet spectroscopy, Infra-red spectroscopy, Nuclear Magnetic Resonance Spectroscopy, substance identity, REACH

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SUMMARY

The REACH Regulation states that spectral data, such as those obtained by ultra-violet (UV), infra-red (IR), and nuclear magnetic resonance (NMR) spectroscopies, are required for substance identification purposes and should be provided by registrants when submitting product dossiers. However, Concawe believes that for virtually all petroleum UVCB (Unknown or Variable composition, Complex reaction products or Biological materials) substances spectral data provide no useful additional information to that obtained by the analytical techniques previously recommended to registrants for characterising their products, and that consequently there is no need for them to provide spectral data when submitting their registrations.

Despite Concawe providing evidence to ECHA in 2011 to support this claim, ECHA has continued to state that spectral data provide valuable additional substance identity information and are therefore required when submitting registrations. In order to provide further information on the value of spectral data Concawe therefore decided that their 2015 Analytical Program, which involved the chemical characterisation of 189 registered petroleum UVCB substances from 20 substance categories, should include the examination of each substance by UV, IR, ^{1}H-NMR and ^{13}C-NMR spectroscopies.

This report presents all the spectral data generated during the Concawe 2015 Analytical Program which represents a much larger data set than that previously submitted to ECHA, and provides further scientific evidence to justify the claim that spectral analysis is unnecessary for the characterisation of virtually all petroleum UVCB substances. It shows that most substances cannot be effectively differentiated from each other by UV, IR, ^{1}H-NMR or ^{13}C-NMR spectroscopies and that, except for two substances with very specific chemical properties, spectroscopic analysis provides no additional information to that obtained by the other techniques recommended to registrants for generating compositional information on their products.

1. INTRODUCTION

REACH Regulation (EC) No 1907/2006 (Annex VI, item 2) includes general information and certain key principles for substance identification and states that the information submitted to support a registration should be sufficient to enable the substance to be identified, adding that if this is not technically possible or not considered scientifically necessary then the reasons should be clearly stated. Annex VI item 2 lists some eighteen sub-items to be considered for substance identification and refers to specific analytical information requirements, namely: spectral data (ultra-violet, infra-red, nuclear magnetic resonance or mass spectrum); and high-pressure liquid chromatogram, or gas chromatogram.

Petroleum substances are UVCBs (Unknown or Variable composition, Complex reaction products or Biological materials) whose composition is defined by their manufacturing process and some basic properties (e.g. carbon number range, boiling point range, viscosity etc.). They are essentially complex mixtures of hydrocarbons and Concawe believes that for virtually all petroleum substances spectral data provide no additional substance identity information to that provided by the analytical techniques previously recommended to registrants [1, 2] for characterising their products; and that consequently there is no reason to submit spectral data to support their registrations.

Documented evidence to support this hypothesis using analytical information supplied by registrants was provided to ECHA by Concawe in 2011 [3], and again during subsequent discussions with ECHA at their Helsinki offices on 26th October 2011 (Concawe subsequently published [4] a virtually unchanged version of this document). ECHA's response to this hypothesis [5] agreed with Concawe's recommendation that analytical techniques used to characterise petroleum substances need to be appropriate for the specific substances and consequently a tailored approach is required for each of the petroleum substance categories. However, ECHA commented that compositional information obtained by chromatographic analysis alone, which represent the major part of analytical techniques recommended by Concawe, might not provide complete information on all constituents present in a substance and that spectral analyses are therefore necessary to detect the presence or absence of certain constituents or groups of constituents.

ECHA provided the following statements to illustrate why, in their opinion, spectral data are required when registering petroleum substances:

- **Ultra-violet (UV) Spectroscopy**

The Beer-Lambert law establishes the relationship between absorbance, sample thickness and the concentration of the absorbing species/chromophoric groups. The description of the sample preparation and recording conditions and the appropriate dilution of the sample and calibration can normally provide useful information on the presence/concentration of aromatics and olefinic constituents.

- **Infra-red (IR) Spectroscopy**

IR reveals the presence or absence of specific hydrocarbon functionalities such as alkyl and aryl groups. It can be used to indicate whether substances are saturated, unsaturated or aromatic and can be used to reveal the presence of many other

functional groups including amines, carbonyls and alcohols. For this reason, IR spectroscopy can provide information about the identity of the substance and confirm the assumptions made to develop the chromatographic method used to characterise a petroleum UVCB substance.

- **Nuclear Magnetic Resonance (NMR) Spectroscopy**

NMR can indicate the presence or absence of specific hydrocarbon classes such as alkanes, alkenes and aromatics as well as giving an indicative relative ratio of their presence. In addition, the DEPT NMR technique can be used for determining the number of protons directly attached to individual carbon-13 nucleus thus providing an indication of linearity or branching of the carbon chain. For this reason, NMR spectroscopy can provide information about the identity of the substance and also confirm the assumptions made to develop the chromatographic method used to characterise a petroleum UVCB substance.

The decision on which analytical techniques should be used to provide substance identity information is the responsibility of the individual registrant. However, if it is not technically possible or considered to be scientifically unnecessary to provide information on one or more of the items listed in Annex VI of the REACH Regulation, robust reasons supported by scientifically based justifications for these omissions should be presented. The purpose of this report is to provide further scientific evidence to that previously submitted to ECHA [3, 4] to justify the claim that spectral analysis is unnecessary for virtually all petroleum UVCB substances. This evidence is based on spectral data generated during the Concawe 2015 Analytical Program [6] which, as shown in **Table 1**, involved the examination of a much wider range of substances than those cited in the previous submission to ECHA.

2. BRIEF DESCRIPTION OF SPECTRAL ANALYSIS TECHNIQUES

This section provides a brief description of the three spectral techniques referred to previously by ECHA together with some general comments on their applicability to UVCB petroleum substances.

2.1. UV SPECTROSCOPY

This technique is used to determine the presence of unsaturated bonds, such as olefinic and aromatic bonds, and heteroatom groups such as ketones, which absorb radiation in the commonly measured 190-400 nm range arising from electronic transitions within molecules. In the case of aromatic hydrocarbons, the wavelengths of the UV absorbance maxima are determined by the nature of the aromaticity; increasing conjugation means that less energy is required for the electronic transitions and results in absorbance at progressively higher wavelengths.

Wavelength	**Hydrocarbon functionality**
190-210 nm	mono-aromatics
220-230 nm	di-aromatics
250-275 nm	tri and tri+ aromatics

Absorbance intensity is particularly strong for components where the unsaturated bonds are conjugated, such as in aromatic hydrocarbons, and UV spectroscopy is therefore particularly sensitive for the measurement of these compounds. For relatively pure substances or multi-component substances where the component of interest has a particularly intense chromophore, the technique can be used for quantitative analysis and purity assessment. However, UV spectroscopy is more commonly used in a qualitative fashion to indicate the presence/absence of unsaturated compounds. UV spectroscopy is usually carried out using either a dilute solution of the sample in a suitable (non-absorbing) solvent, or directly on the sample using a short path-length measurement cell.

In the case of petroleum UVCB substances, UV spectroscopy yields limited information because the spectra obtained are somewhat similar for most products and typically show a strong absorbance at wavelengths below 250-300 nm. As indicated by ECHA, this arises from the very strong UV absorbance of aromatic and/or olefinic hydrocarbons present in these substances. However, because petroleum substances containing even very low concentrations (ppm levels) of these components yield spectra with strong absorption bands, it is not possible to use UV spectroscopy for the accurate measurement of aromatic or olefinic hydrocarbons present in complex petroleum substances. Moreover, UV spectroscopy typically yields broad, unresolved bands owing to the various vibrational and rotational energy levels associated with each electronic transition state, so the wavelength resolution is insufficient to differentiate between absorbances arising from aromatic or olefinic components present in the substance.

2.2. IR SPECTROSCOPY

IR spectroscopy can determine the presence or absence of specific functional groups which absorb radiation at various frequencies in the commonly measured 400-4000 cm^{-1} range through the bending and stretching of bonds within molecules. It can be

used to tell whether substances are saturated, unsaturated or aromatic and, because many functional groups including amines, carbonyls and alcohols can be identified by their characteristic vibration frequencies, IR spectroscopy is often used for characterising relatively pure compounds.

Wavelength	Bond type	Functionality
4000-2500 cm^{-1}	single bonds with light atoms	C-H; O-H; N-H
2500-2000 cm^{-1}	triple bonds	C≡C; C≡N
2000-1500 cm^{-1}	double bonds	C=C; C=O; C=N
1500-400 cm^{-1}	most single bonds	C-C; C-O; C-N; C-halogen

The low-energy region of the spectrum (400-1500 cm^{-1}) is known as the "fingerprint" region because it is particularly characteristic for each compound and can therefore be useful for assessing the purity of simple substances. As with UV spectroscopy, IR spectroscopy of liquid substances is usually carried out either as a dilute solution in a suitable (non-absorbing) solvent or directly using a short path-length measurement cell. Samples can also be examined directly by attenuated total reflectance measurements.

For petroleum substances, IR spectroscopy is mainly used in a qualitative fashion to indicate the presence or absence of specific hydrocarbon functionalities such as alkyl or aryl groups. However, as shown in this report, many different petroleum UVCB substances yield very similar IR spectra and, because the absorbance bands corresponding to unsaturated hydrocarbons are weaker than those associated with saturated hydrocarbons, it does not always provide a good estimate of the degree of aromaticity present in petroleum UVCB substances. Although IR spectroscopy will indicate the presence of other chemical functionalities such as amines, carbonyls and alcohols, these compounds would need to be present at a significant concentration to produce a characteristic absorption band in the IR spectrum of a petroleum UVCB substance. Because nearly all petroleum substances consist almost totally of hydrocarbons, these other functionalities, if present, would not be observed because their absorbance bands would be minute.

2.3. NMR SPECTROSCOPY

NMR provides structural information by showing the environment in which certain atomic nuclei are located. Such nuclei can be energised by application of an external magnetic field and transitions (i.e. resonance) between different energy levels can then be induced by application of radio-frequency energy, the exact frequency of which will only cause transitions in those nuclei located in specific molecular environments. Because both ^{1}H and ^{13}C nuclei give NMR signals, the technique is valuable for elucidating the structure of organic compounds, but only ~1% of the carbon present exists as ^{13}C (the remainder is ^{12}C, which gives no NMR signal) so ^{1}H-NMR is a much more sensitive technique.

Because the magnetic field of each NMR spectrometer is different, an instrument independent way to measure the position of resonance lines, called the chemical shift, is required and this is expressed in parts per million (ppm) corresponding to the difference between the actual resonance frequency and a reference frequency (in Hz), divided by the reference frequency itself (in MHz). The tables below show how chemical shift values can be used to determine the positions of hydrogen and carbon atoms in a molecule and it is therefore possible to use NMR to elucidate the molecular structure of pure substances.

^{1}H-NMR

Chemical shift	Proton type	Environment
0.9 ppm	primary	R-C**H**$_3$
1.3 ppm	secondary	R_2C**H**$_2$
1.5 ppm	tertiary	R_3C-**H**
2.0-4.0 ppm	benzylic	Ar-C-**H**
4.6-5.9 ppm	olefinic	C=C-**H**
6.5-8.5 ppm	aromatic	Ar-**H**

^{13}C-NMR

Chemical shift	Carbon type	Environment
9-60 ppm	alkyl	
14 ppm	terminal methyl	**C**H$_3$-CH$_2$-CH$_2$-CH$_2$-
19 ppm	internal methyl	-CH$_2$-CH(**C**H$_3$)-CH$_2$-
23 ppm	methylene	CH$_3$-**C**H$_2$-CH$_2$-CH$_2$-
30 ppm	methylene	CH$_3$-CH$_2$-CH$_2$-(**C**H$_2$)$_n$-
32 ppm	methylene	CH$_3$-CH$_2$-**C**H$_2$-CH$_2$-
35-45 ppm	branched and cyclic	
100-130 ppm	aromatic (tertiary) and olefinic (tertiary and secondary)	
130-150 ppm	aromatic and olefinic (quaternary)	

Other nuclei which generate signals include ^{19}F, ^{29}Si and ^{31}P although these have little relevance for characterising petroleum UVCB substances which consist predominantly of hydrocarbons. In addition to providing detailed structural information, including discriminating between certain isomers, NMR provides quantitative information on the different types of nuclei present (e.g. CH, CH_2 and CH_3 protons) and is therefore also employed for assessing the purity of simple substances. As indicated by ECHA in their reference to DEPT (Distortionless Enhancement by Polarization Transfer) a range of signal enhancement techniques can also be used to provide greater discrimination and more structural information about the substance under investigation. Most NMR measurements are carried out on solutions of the test substance in a deuterated (^{2}H) solvent such as deuterochloroform. Modern high-field instruments (e.g. 500 MHz) enable most proton NMR spectra to be obtained within a few minutes whereas it may take several hours to obtain a carbon NMR spectrum owing to the relatively small quantity of ^{13}C present in the sample. Although interpretation of complex NMR spectra requires considerable expertise, extensive libraries of reference spectra and predictive computer programs facilitate the routine identification of simple substances.

NMR cannot discriminate between different constituents in a petroleum UVCB substance and the information obtained, whether qualitative or quantitative, therefore only refers to the bulk sample. Moreover, the complexity of these substances is such that it is not possible to resolve all the signals in the NMR spectrum nor assign them to specific nuclear resonances and couplings and, as shown in this report, many different petroleum UVCB substances yield very similar NMR spectra. Some signals can be assigned to specific groups of ^{1}H and ^{13}C nuclei present and, although this information does not permit identification of individual constituents present in the sample, it could theoretically provide quantitative information on the quantities of some chemical functionalities present, such as the total aromatic carbon content of a petroleum substance measured using ^{13}C-NMR.

3. ASSESSMENT OF SPECTRAL ANALYSIS TECHNIQUES FOR SUBSTANCE IDENTIFICATION PURPOSES

The Concawe 2015 Analytical Program [6] involved the chemical characterisation of 189 petroleum UVCB substances from 20 substance categories. Samples of these substances were examined using a range of analytical techniques including UV, IR, ^{1}H-NMR and ^{13}C-NMR spectroscopy. Spectroscopic analysis was carried out on all the substances by Kuwait Petroleum (Kuwait Petroleum Research and Technology, Europoort, Netherlands) in a consistent manner in order to facilitate comparison of the spectral data obtained. In addition to the spectral images, raw spectral data (e.g. wavenumber *vs*. intensity) were provided as Excel files so that, if required in the future, the data could be examined by multi-variate statistical techniques to see whether any correlations can be found between spectral information and specific petroleum UVCB substances.

All the spectra obtained are shown in **Appendix 1** (UV); **Appendix 2** (IR); **Appendix 3** (^{1}H-NMR); and **Appendix 4** (^{13}C-NMR) together with spectral interpretation information for the IR and NMR spectra. The data have been grouped into the 20 substance categories within each appendix to aid comparison of the spectra.

3.1. UV SPECTRA

Examination of the spectra in **Appendix 1** indicates that the heavier substances (e.g. bitumen; distillate aromatic extracts; heavy fuel oils; oxidised asphalt; residual aromatic extracts) only give broad and indistinct absorption bands across the UV region and that there is no significant difference between the spectra obtained across these categories of petroleum substances. Moreover, most of these spectra were obtained on very dilute solutions (5–20 mg/L) of the substances in heptane vindicating the statement made in Section 2.1 that even very low concentrations (ppm levels) of aromatic or olefinic hydrocarbons yield UV spectra with strong absorption bands making it impossible to measure these components accurately in complex petroleum substances.

Although the 28 spectra of the substances in the four gas oil categories (cracked gas oils; other gas oils; straight-run gas oils; vacuum and hydrocracked gas oils and distillate fuels) show slightly more structure, it is still not possible to differentiate the spectra obtained across these categories or to accurately measure the aromatic content of these materials using UV spectroscopy. Moreover, despite the statements made in Section 2.1 about discriminating between mono-, di- and tri+ aromatics by the wavelength ranges of the UV absorption bands observed, it is clearly not possible to measure the individual aromatic classes accurately in complex petroleum substances by this technique. As stated, spectral analysis therefore provides no additional information on the composition of these substances to that obtained by the techniques previously recommended by Concawe for substance identity purposes [1, 2].

The UV spectra of the substances in the kerosine category exhibit similar profiles to the spectra obtained on substances in the four gas oil categories albeit with increased resolution of the two absorption bands in the 200-300 nm range. Although the spectra show that the relative intensity of the low energy band to the high energy band is greater in kerosines than in gas oils, suggesting that the relative concentrations of tri+ to di-aromatics is greater in kerosines than in gas oils, this is

clearly not possible given the refinery conditions employed for the manufacture of these materials and the vast quantity of data generated on these substances using a variety of other analytical procedures. This effect is observed to an even greater extent in the UV spectrum of Sample No. 059 (Mk1 diesel fuel) in which the two absorption bands have almost identical intensities despite this substance being specifically manufactured to contain low total aromatics, as witnessed by the relatively high sample concentration used to record the spectrum, and virtually zero poly-aromatics. These observations raise the possibility that UV spectroscopy might even generate misleading information if used for the quantitative analysis of complex petroleum substances.

The spectrum of Sample No. 011 (kerosine) is particularly noteworthy because, unlike all the other spectra which were obtained on dilute solutions of the kerosine samples in heptane, this spectrum was recorded on the undiluted sample. As shown in **Table 1**, this substance [Hydrocarbons, C9-16, hydrotreated, dearomatized; CAS 93763-35-0; EC 297-854-1: *A complex combination of hydrocarbons obtained as solvents which have been subjected to hydrotreatment in order to convert aromatics to naphthenes by catalytic hydrogenation*] has been hydrotreated to remove aromatic components and consequently it was possible to obtain an on-scale spectrum using an undiluted sample of this substance. Similarly, it was possible to obtain an on-scale spectrum using an undiluted sample of Sample No. 145 (highly refined base oil) owing to the extensive manufacturing processes used to remove aromatics during the production of this petroleum substance.

In common with samples from the middle-distillate substance categories, UV spectra obtained on most of the low boiling point naphtha (LBPN) substances exhibited two main absorption bands in the 200-300 nm range. Those substances which had been manufactured to contain virtually no aromatic components (e.g. Sample Nos. 004, 013, 014, 045, 098A, 098B, 110, 162, 165) yielded on-scale spectra with no sample dilution.

In summary, the only purpose of using UV spectroscopy for the examination of petroleum UVCB substances is to confirm the absence of aromatic or olefinic components. Given that even very low concentrations of these compounds produce significant absorption bands in the 200-300 nm spectral region, the technique is therefore only of value for the examination of those substances where the absence of aromatic or olefinic components is of critical importance, such as highly refined base oils (white mineral oils).

3.2. IR SPECTRA

Examination of the spectra in **Appendix 2** indicates that most spectra exhibit very similar profiles and that in virtually all cases it is not possible to distinguish between substances within a category or even between substances in different categories by IR spectroscopy. The elemental analysis data presented in **Table 1** show that virtually all of the listed petroleum substances essentially contain only carbon and hydrogen and this is reflected in the corresponding IR spectra which only exhibit absorption bands corresponding to perturbations between carbon-carbon and carbon-hydrogen bonds.

Major differences between the types of hydrocarbons present in different petroleum substances are not reflected or even particularly evident in the IR absorption profiles. For example, Sample No. 012 (cracked gas oil) and Sample No. 059 (Mk1 diesel fuel) which have been shown by GCxGC analysis to contain 45.5%

(m/m) and 7.4% (m/m) respectively of aromatic hydrocarbons [6], yield virtually identical IR spectra except for a minor peak at ~1600 cm^{-1} resulting from the much higher aromatic content of Sample No. 012. However, in common with Sample No. 059, the IR spectrum of Sample 119 (other lubricant base oil) shows no peak whatsoever in the ~1600 cm^{-1} spectral region despite GCxGC reporting an aromatic content of 3.3% (m/m) for this sample [6]; the presence of aromatics is also confirmed by the UV spectrum of Sample 119. Hence the ECHA statement about IR indicating *"whether substances are saturated, unsaturated or aromatic"* is not vindicated by the results presented in this study which shows that IR can only detect relatively large concentrations of aromatics in petroleum UVCB substances.

With reference to ECHA's statement that IR *"can be used to reveal the presence of many other functional groups including amines, carbonyls and alcohols"*, **Table 1** shows that relatively few of the registered substances contain a significant concentration of heteroatoms. Sample No. 161 (Petrolatum (petroleum), oxidized), which contains 8.0% (m/m) oxygen [6], is such a substance and the IR spectrum exhibits an absorption band at 1715 cm^{-1} corresponding to a carbon-oxygen bond perturbation which is consistent with the formal description of this substance: *a complex combination of organic compounds, predominantly high molecular weight carboxylic acids, obtained by the air oxidation of petrolatum*. However, as illustrated for aromatic hydrocarbons, IR spectroscopy can only reveal the presence of other functional groups when they are present at unrealistically high concentrations in petroleum UVCB substances. Interestingly, the substances containing the next highest concentrations of heteroatoms after Sample No. 161 are Sample No. 089 (untreated distillate aromatic extract) and Sample No. 186 (residual aromatic extract) which contain 4.5% (m/m) and 3.9% (m/m) sulphur [6] respectively. However, despite being from different substance categories the IR spectra of these two substances are virtually identical and, despite both substances containing over 80% (m/m) of aromatic hydrocarbons [6], their spectra are not markedly different from those obtained on substances with much lower aromatic contents and no significant heteroatom content such as Sample No. 176 (vacuum and hydrocracked gas oil and distillate fuel).

In summary, IR spectroscopy can be used to confirm the presence of unsaturated hydrocarbons but, because the absorbance bands corresponding to these compounds are weaker than those associated with saturated hydrocarbons, such compounds need to be present at relatively high concentrations before they can be detected. As illustrated in this study IR spectroscopy does not provide a good estimate of the degree of aromaticity present in petroleum UVCB substances. Although the technique confirmed the presence of an expected high carbonyl concentration in one substance which, by definition, consists predominantly of high molecular weight carboxylic acids, it would be very difficult to accurately measure the carbonyl concentration of this substance using IR spectroscopy.

3.3. NMR SPECTRA

Appendices 3 and **4** show respectively the ^{1}H-NMR and ^{13}C-NMR spectra obtained on the substances examined together with assignments for the peaks observed at different chemical shift values. In common with UV and IR spectroscopy, NMR cannot discriminate between the multitude of constituents present in a petroleum UVCB substance and the information obtained therefore only refers to the bulk sample.

Examination of the spectra in **Appendix 3** indicates that most spectra exhibit very similar profiles and consequently it is not possible to distinguish between substances within a category or even between substances in different categories using ^{1}H-NMR spectroscopy. The signals arising from methyl (primary), methylene (secondary), and methine (tertiary) protons are not well resolved in most spectra and it is therefore difficult to accurately quantify the concentrations of protons in these different molecular environments. This said, it is possible to see that the LBPN substances contain relatively higher concentrations of methyl to methylene protons than the heavier petroleum substances, which is only to be expected given the lower molecular weight of LBPN components and therefore the higher number of terminal (methyl) groups present in these substances. Similarly, spectra obtained on paraffin and hydrocarbon wax substances, such as Sample No. 063, show a much higher concentration of methylene to methyl protons because these materials have a significantly higher mean molecular weight than LBPN substances and are known to contain a relatively high concentration of straight chain (normal) paraffins.

Although the peaks in most of the ^{1}H-NMR spectra are not well resolved, Sample No. 104 (kerosine), which is manufactured by the distillation of aromatic streams, is a simpler substance than the other kerosine products and therefore yields a more detailed spectrum. As expected, many of the resonances observed can be attributed to protons in an aromatic environment but it is still not possible to accurately determine the aromatic content of this substance from the ^{1}H-NMR spectrum. The integration values show an approximate ratio of 1:2 between aromatic protons and the other protons present in this substance which might initially suggest an aromatic content of 30-35% in this sample. However, it is essential to recognise that the aromatic protons are only those protons directly attached to the aromatic nuclei present in the sample and that any substituents attached to these nuclei will therefore reduce the aromatic content measured by ^{1}H-NMR. In contrast to the ^{1}H-NMR spectrum of Sample No. 104, the integration values in the ^{13}C-NMR spectrum of this sample show an approximate ratio of 2:1 between aromatic carbons (i.e. the carbon atoms in the aromatic nuclei) and the other carbon atoms present in this substance, which would indicate an aromatic content of 65-70%. Not surprisingly given that this substance is manufactured by the distillation of aromatic streams, GCxGC analysis has shown it to consist essentially of only mono- and di-aromatic hydrocarbons [6] and this illustrates the difficulty in using NMR to provide quantitative information on the components present in a petroleum UVCB substance. The ^{13}C-NMR data indicate that 65-70% of the carbon atoms in this substance, which consists solely of aromatic hydrocarbons, are present in aromatic nuclei but, because a different measurement principle is involved, NMR is effectively under-estimating the aromatic content of this sample.

A similar argument applies to all the substances examined in this study. For example, Sample No. 041 (Distillates (petroleum), hydrotreated light catalytic cracked) and Sample No. 130 (Distillates (petroleum), light catalytic cracked) are both cracked gas oils but, owing to the hydrotreatment, Sample No. 041 would be expected to have a much lower aromatic content than Sample No. 130. This is reflected in the ^{1}H-NMR and ^{13}C-NMR spectra recorded on these substances which show approximate ratios between aromatic protons and the other protons of 1:186 and 1:4.4 for Sample Nos. 041 and 130 respectively, and approximate ratios between aromatic carbon atoms and the other carbon atoms of 1:100 and 1:1.4 for Sample Nos. 041 and 130 respectively. The total aromatic contents of these substances measured by GCxGC were 8.4% (m/m) for Sample No. 041 and 68% (m/m) for Sample No. 130 [6].

As indicated in Section 2.3, ^{1}H-NMR is a much more sensitive technique than ^{13}C-NMR because only ~1% of carbon exists as ^{13}C, the remainder being ^{12}C which gives no NMR signal. Despite this, ^{1}H-NMR is not a particularly sensitive technique as illustrated by the spectrum of Sample No. 152 (slack wax) which shows no resonances corresponding to

aromatic protons. However, as shown in **Appendix 1**, the UV spectrum of this sample indicates that it contains aromatic components and liquid column chromatographic analysis of the sample showed it to contain 6.8% (m/m) aromatics [6].

In summary, the value of NMR in providing substance identity information on complex petroleum UVCB substances is very limited. It can only provide qualitative information on the bulk sample rather than constituent groups and, because quantitative information is based on the total proton or carbon atom content rather than on sample mass, it is not possible to directly compare NMR data with those generated using other analytical techniques. Moreover, it has limited sensitivity particularly in the case of ^{13}C-NMR. Thus, the statement from ECHA that *"NMR can indicate the presence or absence of specific hydrocarbon classes such as alkanes, alkenes and aromatics as well as giving an indicative relative ratio of their presence"* has not been vindicated by the data reported here for petroleum UVCB substances.

4. GLOSSARY

CAS	Chemical Abstracts Service (Registry)
ECHA	European Chemicals Agency
GCxGC	Comprehensive Two-Dimensional Gas Chromatography
IR	Infra-red
LBPN	Low Boiling Point Naphthas
NMR	Nuclear Magnetic Resonance
REACH	Registration, Evaluation and Authorisation of Chemicals
SIMG	Substance Identity Management Group
UV	Ultra-Violet
UVCB	Unknown or Variable composition, Complex reaction products or Biological materials

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TABLE 1 – SUBSTANCE INVENTORY AND ELEMENTAL ANALYSIS RESULTS

Sample Number	CAS Number	EC Number	Substance Name	Category	Substance Description	Carbon (% m/m)	Hydrogen (% m/m)	Nitrogen (% m/m)	Oxygen (% m/m)	Sulphur (% m/m)	Total (% m/m)
001	8006-61-9	232-349-1	Gasoline, natural	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons separated from natural gas by processes such as refrigeration or absorption. It consists predominantly of saturated aliphatic hydrocarbons having carbon numbers predominantly in the range of C4 through C8 and boiling in the range of approximately minus 20°C to 120°C (-4°F to 248°F).	84,5	15,6			0,001	100,10
002	68410-05-9	270-077-5	Distillates (petroleum), straight-run Light	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons produced by the distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly in the range of C2 through C7 and boiling in the range of approximately -88°C to 99°C (-127°F to 210°F).	84,8	15,2				100,00
003	92045-29-9	295-411-7	Gas oils (petroleum), thermal-cracked, hydrodesulfurized	CRACKED GAS OILS	No EC number description available in ESIS. CONCAWE substance description: A complex combination of hydrocarbons obtained by treating the thermally-cracked gas oil fraction with hydrogen to convert organic sulfur to hydrogen sulphide which is removed. It consists predominantly of hydrocarbons having carbon numbers in the range of C9 through C24 and boiling in the range of approximately 130°C to 390°C.	86,4	13,3		0,04	0,004	99,74
004	92045-53-9	295-434-2	Naphtha (petroleum), hydrodesulfurized light, dearomatized	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons obtained by distillation of hydrodesulfurized and dearomatized light petroleum fractions. It consists predominantly of C7 paraffins and cycloparaffins boiling in a range of approximately 90°C to 100°C (194°F to 212°F).	84,7	15,3				100,00
006	64741-45-3	265-045-2	Residues (petroleum), atm. tower	HEAVY FUEL OIL COMPONENTS	A complex residuum from the atmospheric distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly greater than C20 and boiling above approximately 350°C (662°F). This stream is likely to contain 5 wt. % or more of 4- to 6-membered condensed ring aromatic hydrocarbons.	86,8	11,9	0,3	0,30	0,570	99,87
007	90669-76-4	292-658-2	Residues (petroleum), vacuum, light	HEAVY FUEL OIL COMPONENTS	A complex residuum from the vacuum distillation of the residuum from atmospheric distillation of crude oil. It consists predominantly of hydrocarbons having carbon numbers predominantly greater than C24 and boiling above approximately 390°C (734°F).	86,5	11,1	0,7	0,30	1,130	99,73
008	92061-97-7	295-511-0	Residues (petroleum), catalytic cracking	HEAVY FUEL OIL COMPONENTS	A complex combination of hydrocarbons produced as the residual fraction from the distillation of the products from a catalytic cracking process. It consists predominantly of hydrocarbons having carbon numbers predominantly greater than C11 and boiling above approximately 200°C (392°F).	89,8	9,8		0,10	0,055	99,76
009	93572-35-1	297-465-7	Hydrocarbons, C7-12, C>9-arom.-rich, reforming heavy fraction	LOW BOILING POINT NAPHTHAS (GASOLINES)	Confusing original description: A complex combination of hydrocarbons obtained by separation from the platformate-containing fraction. It consists predominantly of nonaromatic hydrocarbons having carbon numbers predominantly in the range of C7 through C12 and boiling in the range of approximately 120°C to 210°C (248°F to 380°F) and C9 and higher aromatic hydrocarbons. CONCAWE substance description: A complex combination of hydrocarbons obtained by separation from the platformate-containing fraction. It consists predominantly of aromatic hydrocarbons having carbon numbers in the range of C7 through C12 and boiling in the range of approximately 120°C to 230°C.	89,5	10,0				99,50
010	93763-33-8	297-852-0	Hydrocarbons, C6-11, hydrotreated, dearomatized	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons obtained as solvents which have been subjected to hydrotreatment in order to convert aromatics to naphthenes by catalytic hydrogenation.	85,8	14,2				100,00
011	93763-35-0	297-854-1	Hydrocarbons, C9-16, hydrotreated, dearomatized	KEROSINES	A complex combination of hydrocarbons obtained as solvents which have been subjected to hydrotreatment in order to convert aromatics to naphthenes by catalytic hydrogenation.	85,7	14,3				100,00

Sample Number	CAS Number	EC Number	Substance Name	Category	Substance Description	Carbon (% m/m)	Hydrogen (% m/m)	Nitrogen (% m/m)	Oxygen (% m/m)	Sulphur (% m/m)	Total (% m/m)
012	101316-59-0	309-865-1	Distillates (petroleum), hydrodesulfurized middle coker	CRACKED GAS OILS	A complex combination of hydrocarbons obtained by fractionation from hydrodesulphurised coker distillate stocks. It consists of hydrocarbons having carbon numbers predominantly in the range of C12 through C21 and boiling in the range of approximately 200°C to 360°C (392°F to 680°F).	87,2	12,4		0,05	0,006	99,66
013	101316-66-9	309-870-9	Hydrocarbons, C6-8, hydrogenated sorption-dearomatized, toluene raffination	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons obtained during the sorptions of toluene from a hydrocarbon fraction from cracked gasoline treated with hydrogen in the presence of a catalyst. It consists predominantly of hydrocarbons having carbon numbers predominantly in the range of C6 through C8 and boiling in the range of approximately 80°C to 135°C (176°F to 275°F).	84,3	15,7				100,00
014	101316-67-0	309-871-4	Hydrocarbons, C6-rich, hydrotreated light naphtha distillates, solvent-refined	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons obtained by distillation of hydrotreated naphtha followed by solvent extraction. It consists predominantly of saturated hydrocarbons and boiling in the range of approximately 65°C to 70°C (149°F to 158°F).	84,2	15,9				100,10
015	101316-76-1	309-879-8	Naphtha (petroleum), hydrodesulfurized full-range coker	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons obtained by fractionation from hydrodesulphurised coker distillate. It consists predominantly of hydrocarbons having carbon numbers predominantly in the range of C5 to C11 and boiling in the range of approximately 23°C to 196°C (73°F to 385°F).	85,6	14,1		0,04	0,295	100,04
016	101316-80-7	309-881-9	Solvent naphtha (petroleum), hydrocracked heavy arom.	KEROSINES	Inconsistent original description: A complex combination of hydrocarbons obtained by the distillation of hydrocracked petroleum distillate. It consists predominantly of hydrocarbons having carbon numbers predominantly in the range of C9 through C16 and boiling in the range of approximately 235°C to 290°C (455°F to 554°F).	85,8	14,0				99,80
017	64742-78-5	265-181-2	Residues (petroleum), hydrodesulfurized atmospheric tower	HEAVY FUEL OIL COMPONENTS	A complex combination of hydrocarbons obtained by treating an atmospheric tower residuum with hydrogen in the presence of a catalyst under conditions primarily to remove organic sulfur compounds. It consists of hydrocarbons having carbon numbers predominantly greater than C20 and boiling above approximately 350°C (662°F). This stream is likely to contain 5 wt. % or more of 4- to 6-membered condensed ring aromatic hydrocarbons.	86,8	12,2	0,3	0,10	0,569	99,97
018	64741-57-7	265-058-3	Gas oils (petroleum), heavy vacuum	HEAVY FUEL OIL COMPONENTS	A complex combination of hydrocarbons produced by the vacuum distillation of the residuum from atmospheric distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly in the range of C20 through C50 and boiling in the range of approximately 350°C to 600°C (662°F to 1112°F). This stream is likely to contain 5 wt. % or more of 4- to 6-membered condensed ring aromatic hydrocarbons.	86,4	12,9	0,2	0,20	0,458	100,16
019	64741-69-1	265-071-4	Naphtha (petroleum), light hydrocracked	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons from distillation of the products from a hydrocracking process. It consists predominantly of saturated hydrocarbons having carbon numbers predominantly in the range of C4 through C10, and boiling in the range of approximately minus 20°C to 180°C (-4°F to 356°F).	86,0	14,1			0,007	100,11
020	64741-80-6	265-081-9	Residues (petroleum), thermal cracked	HEAVY FUEL OIL COMPONENTS	A complex combination of hydrocarbons produced as the residual fraction from distillation of the product from a thermal cracking process. It consists predominantly of unsaturated hydrocarbons having carbon numbers predominantly greater than C20 and boiling above approximately 350°C (662°F). This stream is likely to contain 5 wt. % or more of 4- to 6-membered condensed ring aromatic hydrocarbons.	85,5	10,4	0,7	0,50	2,630	99,73
021	64741-81-7	265-082-4	Distillates (petroleum), heavy thermal cracked	HEAVY FUEL OIL COMPONENTS	A complex combination of hydrocarbons from the distillation of the products from a thermal cracking process. It consists predominantly of unsaturated hydrocarbons having carbon numbers predominantly in the range of C15 through C36 and boiling in the range of approximately 260°C to 480°C (500°F to 896°F). This stream is likely to contain 5 wt. % or more of 4- to 6-membered condensed ring aromatic hydrocarbons.	84,4	11,4	0,4	0,20	3,400	99,80
022	64741-87-3	265-089-2	Naphtha (petroleum), sweetened	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons obtained by subjecting a petroleum naphtha to a sweetening process to convert mercaptans or to remove acidic impurities. It consists of hydrocarbons having carbon numbers predominantly in the range of C4 through C12 and boiling in the range of approximately minus 10°C to 230°C (14°F to 446°F).	87,0	13,0			0,052	100,05

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023	64742-73-0	265-178-6	Naphtha (petroleum), hydrodesulfurized light	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons obtained from a catalytic hydrodesulfurization process. It consists of hydrocarbons having carbon numbers predominantly in the range of C4 through C11 and boiling in the range of approximately minus 20°C to 190°C (-4°F to 374°F).	84,3	15,8				100,10
025	68333-22-2	269-777-3	Residues (petroleum), atmospheric	HEAVY FUEL OIL COMPONENTS	A complex residuum from atmospheric distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly greater than C11 and boiling above approximately 200°C (392°F). This stream is likely to contain 5 wt.% or more of 4- to 6-membered condensed ring aromatic hydrocarbons.	84,7	11,5	0,3	0,30	3,220	100,02
026	68475-79-6	270-660-4	Distillates (petroleum), catalytic reformed depentanizer	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons from the distillation of products from a catalytic reforming process. It consists predominantly of aliphatic hydrocarbons having carbon numbers predominantly in the range of C3 through C6 and boiling in the range of approximately -49°C to 63°C (-57°F to 145°F).	83,6	16,6				100,20
027	68527-27-5	271-267-0	Naphtha (petroleum), full-range alkylate, butane-contg.	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons produced by the distillation of the reaction products of isobutane with monoolefinic hydrocarbons usually ranging in carbon numbers from C3 through C5. It consists of predominantly branched chain saturated hydrocarbons having carbon numbers predominantly in the range of C7 through C12 with some butanes and boiling in the range of approximately 35°C to 200°C (95°F to 428°F).	84,2	15,8				100,00
028	68783-08-4	272-184-2	Gas oils (petroleum), heavy atmospheric	HEAVY FUEL OIL COMPONENTS	A complex combination of hydrocarbons obtained by the distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly in the range of C7 through C35 and boiling in the range of approximately 121°C to 510°C (250°F to 950°F).	85,5	12,3	0,2	0,10	1,660	99,76
029	68783-12-0	272-186-3	Naphtha (petroleum), unsweetened	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons produced from the distillation of naphtha streams from various refinery processes. It consists of hydrocarbons having carbon numbers predominantly in the range of C5 through C12 and boiling in the range of approximately 0°C to 230°C (25°F to 446°F).	85,9	14,1			0,013	100,01
030	68955-35-1	273-271-8	Naphtha (petroleum), catalytic reformed	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons produced by the distillation of products from a catalytic reforming process. It consists of hydrocarbons having carbon numbers predominantly in the range of C4 through C12 and boiling in the range of approximately 30°C to 220°C (90°F to 430°F). It contains a relatively large proportion of aromatic and branched chain hydrocarbons. This stream may contain 10 vol. % or more benzene.	85,7	14,3				100,00
031	70592-78-8	274-685-1	Distillates (petroleum), vacuum	HEAVY FUEL OIL COMPONENTS	A complex combination of hydrocarbons produced by the vacuum distillation of the residuum from atmospheric distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly in the range of C15 through C50 and boiling in the range of approximately 270°C to 600°C (518°F to 1112°F). This stream is likely to contain 5 wt.% or more of 4- to 6-membered condensed ring aromatic hydrocarbons.	85,1	12,3	0,2	0,10	2,610	100,31
033	92045-64-2	295-446-8	Hydrocarbons, C6-7, naphtha-cracking, solvent-refined	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons obtained by the sorption of benzene from a catalytically fully hydrogenated benzene-rich hydrocarbon cut that was distillatively obtained from prehydrogenated cracked naphtha. It consists predominantly of paraffinic and naphthenic hydrocarbons having carbon numbers predominantly in the range of C6 through C7 and boiling in the range of approximately 70°C to 100°C (158°F to 212°F).	85,6	14,4				100,00
034	64741-62-4	265-064-6	Clarified oils (petroleum), catalytic cracked	HEAVY FUEL OIL COMPONENTS	A complex combination of hydrocarbons produced as the residual fraction from distillation of the products from a catalytic cracking process. It consists of hydrocarbons having carbon numbers predominantly greater than C20 and boiling above approximately 350°C (662°F). This stream is likely to contain 5 wt. % or more of 4- to 6-membered condensed ring aromatic hydrocarbons.	91,8	7,2	0,2	0,20	0,172	99,57
035	64742-89-8	265-192-2	Solvent naphtha (petroleum), light aliph.	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons obtained from the distillation of crude oil or natural gasoline. It consists predominantly of saturated hydrocarbons having carbon numbers predominantly in the range of C5 through C10 and boiling in the range of approximately 35°C to 160°C (95°F to 320°F).	84,2	15,9		0,05		100,15
036	93572-43-1	297-474-6	Lubricating oils (petroleum), base oils, paraffinic	OTHER LUBRICANT BASE OILS	A complex combination of hydrocarbons obtained by refining of crude oil. It consists predominantly of aromatics, naphthenics and paraffinics and produces a finished oil with a viscosity of 120 SUS at 100°F (23cSt at 40°C).	86,8	12,4	0,3	0,21	0,345	100,06

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037	68476-50-6	270-690-8	Hydrocarbons, C≥5, C5-6-rich	LOW BOILING POINT NAPHTHAS (GASOLINES)	No EC number description available in ESIS. CONCAWE substance description: A complex combination of hydrocarbons obtained from the distillation of naphtha streams. It consists predominantly of saturated hydrocarbons having carbon numbers in the range of C4 through C8, the vast majority of which are C5 and C6 components, and boiling in the range of approximately 25°C to 120°C.	84,4	15,6		0,04		100,04
038	68513-03-1	270-993-5	Naphtha (petroleum), light catalytic reformed, arom.-free	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons obtained from distillation of products from a catalytic reforming process. It consists predominantly of hydrocarbons having carbon numbers predominantly in the range of C5 through C8 and boiling in the range of approximately 35°C to 120°C (95°F to 248°F). It contains a relatively large proportion of branched chain hydrocarbons with the aromatic components removed.	85,1	14,9		0,04		100,04
039	64741-41-9	265-041-0	Naphtha (petroleum), heavy straight-run	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons produced by distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly in the range of C6 through C12 and boiling in the range of approximately 65°C to 230°C (149°F to 446°F).	85,8	14,2		0,04	0,002	100,04
040	68410-71-9	270-088-5	Raffinates (petroleum), catalytic reformer ethylene glycol-water countercurrent exts.	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons obtained as the raffinate from the UDEX extraction process on the catalytic reformer stream. It consists of saturated hydrocarbons having carbon numbers predominantly in the range of C6 through C9.	85,9	13,9				99,80
041	68921-07-3	272-930-7	Distillates (petroleum), hydrotreated light catalytic cracked	CRACKED GAS OILS	A complex combination of hydrocarbons obtained by treating a petroleum fraction with hydrogen in the presence of a catalyst.	85,8	14,1				99,90
042	91995-68-5	295-331-2	Extracts (petroleum), catalytic reformed light naphtha solvent	LOW BOILING POINT NAPHTHAS (GASOLINES)	Inconsistent original description: A complex combination of hydrocarbons obtained as the extract from the solvent extraction of a catalytically reformed petroleum cut. It consists predominantly of aromatic hydrocarbons having carbon numbers predominantly in the range of C7 through C8 and boiling in the range of approximately 100°C to 200°C (212°F to 392°F). CONCAWE substance description: A mixture of hydrocarbons obtained as the extract from the solvent extraction of a catalytically reformed petroleum cut. It consists predominantly of aromatic hydrocarbons having carbon numbers predominantly in the range of C6 through C8 and boiling in the range of approximately 80°C to 150°C.	91,1	8,8				99,90
043	8008-20-6	232-366-4	Kerosine (petroleum)	KEROSINES	A complex combination of hydrocarbons produced by the distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly in the range of C9 through C16 and boiling in the range of approximately 150°C to 290°C (320°F to 554°F).	85,7	14,4			0,062	100,16
044	64742-66-1	265-170-2	Naphtha (petroleum), catalytic dewaxed	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons obtained from the catalytic dewaxing of a petroleum fraction. It consists predominantly of hydrocarbons having carbon numbers predominantly in the range of C5 through C12 and boiling in the range of approximately 35°C to 230°C (95°F to 446°F).	85,1	14,7				99,80
045	68476-55-1	270-695-5	Hydrocarbons, C5-rich	LOW BOILING POINT NAPHTHAS (GASOLINES)	No EC number description available in ESIS. CONCAWE substance description: A mixture of hydrocarbons obtained by distillation of naphtha streams. It consists almost entirely of C5 paraffinic components boiling in the range of approximately 25°C to 40°C.	83,3	16,7				100,00
046	64741-78-2	265-079-8	Naphtha (petroleum), heavy hydrocracked	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons from distillation of the products from a hydrocracking process. It consists predominantly of saturated hydrocarbons having carbon numbers predominantly in the range of C6 through C12, and boiling in the range of approximately 65°C to 230°C (148°F to 446°F).	85,3	14,7				100,00
047	101795-01-1	309-976-5	Naphtha (petroleum), sweetened light	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons obtained by subjecting a petroleum naphtha to a sweetening process to convert mercaptans or to remove acidic impurities. It consists predominantly of hydrocarbons having carbon numbers predominantly in the range of C5 through C8 and boiling in the range of approximately 20°C to 130°C (68°F to 266°F).	84,0	16,0		0,05		100,05

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048	68783-11-9	614-725-0	Naphtha (petroleum), light polymn.	LOW BOILING POINT NAPHTHAS (GASOLINES)	No EC number description available in ESIS. TSCA substance description: A complex combination of hydrocarbons produced by the catalytic polymerization of a mixture rich in propylene. It consists predominantly of olefinic hydrocarbons having carbon numbers predominantly in the range of C5 through C11 and boiling in the range of approximately 25 degree C to 185 degree C (77 degree F to 365 degree F).	86,5	13,8				100,30
049	64742-47-8	265-149-8	Distillates (petroleum), hydrotreated light	KEROSINES	A complex combination of hydrocarbons obtained by treating a petroleum fraction with hydrogen in the presence of a catalyst. It consists of hydrocarbons having carbon numbers predominantly in the range of C9 through C16 and boiling in the range of approximately 150°C to 290°C (302°F to 554°F).	85,9	14,1			0,034	100,03
050	70592-76-6	274-683-0	Distillates (petroleum), intermediate vacuum	HEAVY FUEL OIL COMPONENTS	A complex combination of hydrocarbons produced by the vacuum distillation of the residuum from atmospheric distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly in the range of C14 through C42 and boiling in the range of approximately 250°C to 545°C (482°F to 1013°F). This stream is likely to contain 5 wt.% or more of 4- to 6-membered condensed ring aromatic hydrocarbons.	85,3	12,3	0,2	0,10	1,870	99,77
052	93572-36-2	297-466-2	Hydrocarbons, C5-11, nonaroms.-rich, reforming light fraction	LOW BOILING POINT NAPHTHAS (GASOLINES)	Inconsistent original description: A complex combination of hydrocarbons obtained by separation from the platformate-containing fraction. It consists predominantly of nonaromatic hydrocarbons having carbon numbers predominantly in the range of C5 through C11 and boiling in the range of approximately 35°C to 125°C (94°F to 257°F), benzene and toluene. CONCAWE substance description: A complex combination of hydrocarbons obtained by separation from the platformate-containing fraction. It consists predominantly of hydrocarbons having carbon numbers in the range of C5 through C9 and boiling in the range of approximately 35°C to 130°C. It may contain relatively high concentrations of benzene and toluene.	89,6	10,3				99,90
053	92045-59-5	295-441-0	Naphtha (petroleum), light catalytic cracked sweetened	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons obtained by subjecting naphtha from a catalytic cracking process to a sweetening process to convert mercaptans or to remove acidic impurities. It consists predominantly of hydrocarbons boiling in a range of approximately 35°C to 210°C (95°F to 410°F).	86,8	13,4		0,04	0,001	100,24
054	92045-50-6	295-431-6	Naphtha (petroleum), heavy catalytic cracked, sweetened	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons obtained by subjecting a catalytic cracked petroleum distillate to a sweetening process to convert mercaptans or to remove acidic impurities. It consists predominantly of hydrocarbons having carbon numbers predominantly in the range of C6 through C12 and boiling in the range of approximately 60°C to 200°C (140°F to 392°F).	88,4	11,4		0,04	0,220	100,06
055	64741-84-0	265-086-6	Naphtha (petroleum), solvent-refined light	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons obtained as the raffinate from a solvent extraction process. It consists predominantly of aliphatic hydrocarbons having carbon numbers predominantly in the range of C5 through C11 and boiling in the range of approximately 35°C to 190°C (95°F to 374°F).	84,5	15,9				100,40
056	68603-08-7	271-635-0	Naphtha (petroleum), arom	LOW BOILING POINT NAPHTHAS (GASOLINES)	No EC number description available in ESIS. CONCAWE substance description: A mixture of hydrocarbons obtained by distillation of aromatic-rich petroleum streams. It consists almost entirely of C6-8 aromatic components boiling in the range of approximately 85°C to 140°C.	91,4	8,5				99,90
057	68606-11-1	271-727-0	Gasoline, straight-run, topping-plant	LOW BOILING POINT NAPHTHAS (GASOLINES)	Very precise boiling range in original description: A complex combination of hydrocarbons produced from the topping plant by the distillation of crude oil. It boils in the range of approximately 36.1°C to 193.3°C (97°F to 380°F).	84,6	15,6			0,101	100,30
058	70592-77-7	274-684-6	Distillates (petroleum), light vacuum	HEAVY FUEL OIL COMPONENTS	Inconsistent original description: A complex combination of hydrocarbons produced by the vacuum distillation of the residuum from atmospheric distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly in the range of C11 through C35 and boiling in the range of approximately 250°C to 545°C (482°F to 1013°F). CONCAWE substance description: A complex combination of hydrocarbons produced by the vacuum distillation of the residuum from atmospheric distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly in the range of C11 through C50 and boiling in the range of approximately 200°C to 600°C.	85,6	12,2	0,3	0,10	1,400	99,60

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059	64742-47-8	931-250-7	MK1 diesel fuel	MK1 Diesel Fuel	No EC number description available in ESIS. CONCAWE substance description: A complex combination of hydrocarbons obtained by treating a petroleum fraction with hydrogen in the presence of a catalyst. It consists of hydrocarbons having carbon numbers predominantly in the range of C10 through C18 and boiling in the range of approximately 180°C to 320°C.	85,4	14,4				99,80
060	94733-08-1	305-588-5	Distillates (petroleum), solvent-refined hydrotreated heavy, hydrogenated	OTHER LUBRICANT BASE OILS	No EC number description available in ESIS. CONCAWE substance description: A complex combination of hydrocarbons obtained by hydrogenation of the raffinate from a solvent extraction process. It consists predominantly of hydrocarbons having carbon numbers in the range of C20 through C60 and boiling in the range of approximately 350°C to 600°C.	86,3	13,5		0,05	0,140	99,99
061	64742-43-4	265-145-6	Paraffin waxes (petroleum), clay-treated	PARAFFIN AND HYDROCARBON WAXES	A complex combination of hydrocarbons obtained by treatment of a petroleum wax fraction with natural or modified clay in either a contacting or percolation process to remove the trace amounts of polar compounds and impurities present. It consists predominantly of straight chain saturated hydrocarbons having carbon numbers in the range of C20 through C50.	85,2	14,8			0,022	100,02
062	8002-74-2	232-315-6	Paraffin waxes and Hydrocarbon waxes	PARAFFIN AND HYDROCARBON WAXES	A complex combination of hydrocarbons obtained from petroleum fractions by solvent crystallization (solvent deoiling) or by the sweating process. It consists predominantly of straight chain hydrocarbons having carbon numbers predominantly greater than C20.	85,2	14,7			0,071	99,97
063	63231-60-7	264-038-1	Paraffin waxes and Hydrocarbon waxes, microcryst.	PARAFFIN AND HYDROCARBON WAXES	A complex combination of long, branched chain hydrocarbons obtained from residual oils by solvent crystallization. It consists predominantly of saturated straight and branched chain hydrocarbons predominantly greater than C35.	85,3	14,1			0,332	99,73
064	64741-51-1	265-052-0	Distillates (petroleum), heavy paraffinic	UNREFINED / ACID TREATED OILS	A complex combination of hydrocarbons produced by vacuum distillation of the residuum from atmospheric distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly in the range of C20 through C50 and produces a finished oil with a viscosity of at least 100 SUS at 100°F (19cSt at 40°C). It contains a relatively large proportion of saturated aliphatic hydrocarbons.	85,0	12,2	0,1		2,560	99,86
065	64742-51-4	265-154-5	Paraffin waxes (petroleum), hydrotreated	PARAFFIN AND HYDROCARBON WAXES	A complex combination of hydrocarbons obtained by treating a petroleum wax with hydrogen in the presence of a catalyst. It consists predominantly of straight chain paraffinic hydrocarbons having carbon numbers predominantly in the range of about C20 through C50.	85,2	14,8				100,00
066	64742-56-9	265-159-2	Distillates (petroleum), solvent-dewaxed light paraffinic	OTHER LUBRICANT BASE OILS	A complex combination of hydrocarbons obtained by removal of normal paraffins from a petroleum fraction by solvent crystallization. It consists predominantly of hydrocarbons having carbon numbers predominantly in the range of C15 through C30 and produces a finished oil with a viscosity of less than 100 SUS at 100°F (19cSt at 40°C).	86,1	13,5			0,497	100,10
067	64742-60-5	265-163-4	Hydrocarbon waxes (petroleum), hydrotreated microcryst.	PARAFFIN AND HYDROCARBON WAXES	A complex combination of hydrocarbons obtained by treating a petroleum microcrystalline wax with hydrogen in the presence of a catalyst. It consists predominantly of long, branched chain hydrocarbons having carbon numbers predominantly in the range of C25 through C50.	85,5	14,5			0,003	100,00
068	64741-74-8	265-075-6	Naphtha (petroleum), light thermal cracked	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons from distillation of products from a thermal cracking process. It consists predominantly of unsaturated hydrocarbons having carbon numbers predominantly in the range of C4 through C8 and boiling in the range of approximately minus 10°C to 130°C (14°F to 266°F).	85,3	14,4		0,06	0,800	100,56
069	68783-04-0	272-180-0	Extracts (petroleum), solvent-refined heavy paraffinic distillate solvent	TREATED DISTILLATE AROMATIC EXTRACTS	A complex combination of hydrocarbons obtained as the extract from the re-extraction of solvent-refined heavy paraffinic distillate. It consists of saturated and aromatic hydrocarbons having carbon numbers predominantly in the range of C20 through C50.	85,0	11,8	0,1	0,10	2,920	99,92

Sample Number	CAS Number	EC Number	Substance Name	Category	Substance Description	Carbon (% m/m)	Hydrogen (% m/m)	Nitrogen (% m/m)	Oxygen (% m/m)	Sulphur (% m/m)	Total (% m/m)
070	64741-82-8	265-084-5	Distillates (petroleum), light thermal cracked	CRACKED GAS OILS	A complex combination of hydrocarbons from the distillation of the products from a thermal cracking process. It consists predominantly of unsaturated hydrocarbons having carbon numbers predominantly in the range of C10 through C22 and boiling in the range of approximately 160°C to 370°C (320°F to 698°F).	86,9	12,3	0,2	0,16	0,365	99,93
071	68512-62-9	270-984-6	Residues (petroleum), light vacuum	HEAVY FUEL OIL COMPONENTS	A complex residuum from the vacuum distillation of the residuum from the atmospheric distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly greater than C13 and boiling above approximately 230°C (446°F).	86,3	12,6	0,2	0,30	0,561	99,96
072	64741-96-4	265-097-6	Distillates (petroleum), solvent-refined heavy naphthenic	OTHER LUBRICANT BASE OILS	A complex combination of hydrocarbons obtained as the raffinate from a solvent extraction process. It consists of hydrocarbons having carbon numbers predominantly in the range of C20 through C50 and produces a finished oil with a viscosity of at least 100 SUS at 100°F (19cSt at 40°C). It contains relatively few normal paraffins.	86,0	13,1		0,05	0,922	100,07
073	64741-97-5	265-098-1	Distillates (petroleum), solvent-refined light naphthenic	OTHER LUBRICANT BASE OILS	A complex combination of hydrocarbons obtained as the raffinate from a solvent extraction process. It consists of hydrocarbons having carbon numbers predominantly in the range of C15 through C30 and produces a finished oil with a viscosity of less than 100 SUS at 100°F (19 cSt at 40°C). It contains relatively few normal paraffins.	86,2	13,3			0,609	100,11
074	64742-53-6	265-156-6	Distillates (petroleum), hydrotreated light naphthenic	OTHER LUBRICANT BASE OILS	A complex combination of hydrocarbons obtained by treating a petroleum fraction with hydrogen in the presence of a catalyst. It consists of hydrocarbons having carbon numbers predominantly in the range of C15 through C30 and produces a finished oil with a viscosity of less than 100 SUS at 100°F (19cSt at 40°C). It contains relatively few normal paraffins.	86,6	13,5				100,10
075	64742-52-5	265-155-0	Distillates (petroleum), hydrotreated heavy naphthenic	OTHER LUBRICANT BASE OILS	A complex combination of hydrocarbons obtained by treating a petroleum fraction with hydrogen in the presence of a catalyst. It consists of hydrocarbons having carbon numbers predominantly in the range of C20 through C50 and produces a finished oil of at least 100 SUS at 100°F (19cSt at 40°C). It contains relatively few normal paraffins.	87,1	12,7		0,08	0,113	99,99
076	68513-02-0	270-991-4	Naphtha (petroleum), full-range coker	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons produced by the distillation of products from a fluid coker. It consists predominantly of unsaturated hydrocarbons having carbon numbers predominantly in the range of C4 through C15 and boiling in the range of approximately 43°C to 250°C (110°F-500°F).	85,8	14,1		0,05	0,185	100,14
077	85116-59-2	285-510-3	Naphtha (petroleum), catalytic reformed light, arom.-free fraction	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons remaining after removal of aromatic compounds from catalytic reformed light naphtha in a selective absorption process. It consists predominantly of paraffinic and cyclic compounds having carbon numbers predominantly in the range of C5 to C8 and boiling in the range of approximately 66°C to 121°C (151°F to 250°F).	84,9	15,3				100,20
078	68476-33-5	270-675-6	Fuel oil, residual	HEAVY FUEL OIL COMPONENTS	The liquid product from various refinery streams, usually residues. The composition is complex and varies with the source of the crude oil.	84,7	11,0	0,5	0,50	2,780	99,48
079	68607-30-7	271-763-7	Residues (petroleum), topping plant, low-sulfur	HEAVY FUEL OIL COMPONENTS	A low-sulfur complex combination of hydrocarbons produced as the residual fraction from the topping plant distillation of crude oil. It is the residuum after the straight-run gasoline cut, kerosene cut and gas oil cut have been removed.	86,6	12,3	0,2	0,30	0,355	99,76
080	92045-14-2	295-396-7	Fuel oil, heavy, high-sulfur	HEAVY FUEL OIL COMPONENTS	A complex combination of hydrocarbons obtained by the distillation of crude petroleum. It consists predominantly of aliphatic, aromatic and cycloaliphatic hydrocarbons having carbon numbers predominantly higher than C25 and boiling above approximately 400°C (752°F).	85,2	10,6	0,5	0,50	2,810	99,61
081	74869-22-0	278-012-2	Lubricating oils	OTHER LUBRICANT BASE OILS	A complex combination of hydrocarbons obtained from solvent extraction and dewaxing processes. It consists predominantly of saturated hydrocarbons having carbon numbers in the range C15 through C50.	85,5	12,9			1,440	99,84

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082	64741-50-0	265-051-5	Distillates (petroleum), light paraffinic	UNREFINED / ACID TREATED OILS	A complex combination of hydrocarbons produced by vacuum distillation of the residuum from atmospheric distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly in the range of C15 through C30 and produces a finished oil with a viscosity of less than 100 SUS at 100°F (19cSt at 40°C). It contains a relatively large proportion of saturated aliphatic hydrocarbons normally present in this distillation range of crude oil.						
083	64741-52-2	265-053-6	Distillates (petroleum), light naphthenic	UNREFINED / ACID TREATED OILS	A complex combination of hydrocarbons produced by vacuum distillation of the residuum from atmospheric distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly in the range of C15 through C30 and produces a finished oil with a viscosity of less than 100 SUS at 100°F (19cSt at 40°C). It contains relatively few normal paraffins.						
084	64741-53-3	265-054-1	Distillates (petroleum), heavy naphthenic	UNREFINED / ACID TREATED OILS	A complex combination of hydrocarbons produced by vacuum distillation of the residuum from atmospheric distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly in the range of C20 through C50 and produces a finished oil with a viscosity of at least 100 SUS at 100°F (19cSt at 40°C). It contains relatively few normal paraffins.						
085A	64742-65-0	265-169-7	Distillates (petroleum), solvent-dewaxed heavy paraffinic	OTHER LUBRICANT BASE OILS	A complex combination of hydrocarbons obtained by removal of normal paraffins from a petroleum fraction by solvent crystallization. It consists predominantly of hydrocarbons having carbon numbers predominantly in the range of C20 through C50 and produces a finished oil with a viscosity not less than 100 SUS at 100°F (19cSt at 40°C).	86,2	13,7			0,212	100,11
085B	64742-65-0	265-169-7	Distillates (petroleum), solvent-dewaxed heavy paraffinic	OTHER LUBRICANT BASE OILS	A complex combination of hydrocarbons obtained by removal of normal paraffins from a petroleum fraction by solvent crystallization. It consists predominantly of hydrocarbons having carbon numbers predominantly in the range of C20 through C50 and produces a finished oil with a viscosity not less than 100 SUS at 100°F (19cSt at 40°C).	86,0	13,6			0,507	100,11
085C	64742-65-0	265-169-7	Distillates (petroleum), solvent-dewaxed heavy paraffinic	OTHER LUBRICANT BASE OILS	A complex combination of hydrocarbons obtained by removal of normal paraffins from a petroleum fraction by solvent crystallization. It consists predominantly of hydrocarbons having carbon numbers predominantly in the range of C20 through C50 and produces a finished oil with a viscosity not less than 100 SUS at 100°F (19cSt at 40°C).	86,2	13,6			0,224	100,02
085D	64742-65-0	265-169-7	Distillates (petroleum), solvent-dewaxed heavy paraffinic	OTHER LUBRICANT BASE OILS	A complex combination of hydrocarbons obtained by removal of normal paraffins from a petroleum fraction by solvent crystallization. It consists predominantly of hydrocarbons having carbon numbers predominantly in the range of C20 through C50 and produces a finished oil with a viscosity not less than 100 SUS at 100°F (19cSt at 40°C).	86,2	13,5			0,220	99,92
086	64742-81-0	265-184-9	Kerosine (petroleum), hydrodesulfurized	KEROSINES	A complex combination of hydrocarbons obtained from a petroleum stock by treating with hydrogen to convert organic sulfur to hydrogen sulfide which is removed. It consists of hydrocarbons having carbon numbers predominantly in the range of C9 through C16 and boiling in the range of approximately 150°C to 290°C (302°F to 554°F).	86,0	14,1			0,001	100,10
087	64742-31-0	265-132-5	Distillates (petroleum), chemically neutralized light	KEROSINES	A complex combination of hydrocarbons produced by a treating process to remove acidic materials. It consists of hydrocarbons having carbon numbers predominantly in the range of C9 through C16 and boiling in the range of approximately 150°C to 290°C (302°F to 554°F).	85,8	14,3				100,10
089	64742-05-8	265-104-2	Extracts (petroleum), light paraffinic distillate solvent	UNTREATED DISTILLATE AROMATIC EXTRACTS	A complex combination of hydrocarbons obtained as the extract from a solvent extraction process. It consists predominantly of aromatic hydrocarbons having carbon numbers predominantly in the range of C15 through C30. This stream is likely to contain 5 wt. % or more of 4- to 6-membered condensed ring aromatic hydrocarbons.	84,6	10,3	0,2	0,20	4,540	99,84
090	64742-67-2	265-171-8	Foots oil (petroleum)	FOOTS OILS	A complex combination of hydrocarbons obtained as the oil fraction from a solvent deoiling or a wax sweating process. It consists predominantly of branched chain hydrocarbons having carbon numbers predominantly in the range of C20 through C50.	85,5	14,2			0,264	99,96

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091	68553-00-4	271-384-7	Fuel oil, no. 6	HEAVY FUEL OIL COMPONENTS	A distillate oil having a minimum viscosity of 900 SUS at 37.7°C (100°F) to a maximum of 9000 SUS at 37.7°C (100°F).	86,6	11,3	0,4	0,30	0,939	99,54
092	101316-72-7	309-877-7	Lubricating oils (petroleum), C24-50, solvent-extd., dewaxed, hydrogenated	OTHER LUBRICANT BASE OILS	A complex combination of hydrocarbons obtained by solvent extraction and hydrogenation of atmospheric distillation residues. It consists predominantly of hydrocarbons having carbon numbers predominantly in the range of C24 through C50 and produces a finished oil with a viscosity in the order of 16cSt to 75cSt at 40°C (104°F).	85,6	13,6			0,844	100,04
093	8009-03-8	232-373-2	Petrolatum	PETROLATUMS	A complex combination of hydrocarbons obtained as a semi-solid from dewaxing paraffinic residual oil. It consists predominantly of saturated crystalline and liquid hydrocarbons having carbon numbers predominantly greater than C25.	85,3	14,5			0,106	99,91
094	91995-18-5	295-279-0	Aromatic hydrocarbons, C8, catalytic reforming-derived	LOW BOILING POINT NAPHTHAS (GASOLINES)	No EC number description available in ESIS. CONCAWE substance description: A mixture of hydrocarbons obtained by the catalytic reforming of petroleum streams. It consists almost entirely of C8 aromatic components boiling in the range of approximately 135°C to 145°C.	90,4	9,5				99,90
095	93165-19-6	296-903-4	Distillates (petroleum), C6-rich	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons obtained from the distillation of a petroleum feedstock. It consists predominantly of hydrocarbons having carbon numbers of C5 through C7, rich in C6, and boiling in the range of approximately 60°C to 70°C (140°F to 158°F).	85,4	14,8				100,20
096A	64742-04-7	265-103-7	Extracts (petroleum), heavy paraffinic distillate solvent	UNTREATED DISTILLATE AROMATIC EXTRACTS	A complex combination of hydrocarbons obtained as the extract from a solvent extraction process. It consists predominantly of aromatic hydrocarbons having carbon numbers predominantly in the range of C20 through C50. This stream is likely to contain 5 wt. % or more of 4- to 6-membered condensed ring aromatic hydrocarbons.	85,2	11,1	0,3	0,40	2,930	99,93
096B	64742-04-7	265-103-7	Extracts (petroleum), heavy paraffinic distillate solvent	UNTREATED DISTILLATE AROMATIC EXTRACTS	A complex combination of hydrocarbons obtained as the extract from a solvent extraction process. It consists predominantly of aromatic hydrocarbons having carbon numbers predominantly in the range of C20 through C50. This stream is likely to contain 5 wt. % or more of 4- to 6-membered condensed ring aromatic hydrocarbons.	85,1	11,1	0,4	0,40	2,800	99,80
097	68478-17-1	270-796-4	Residues (petroleum), heavy coker gas oil and vacuum gas oil	HEAVY FUEL OIL COMPONENTS	A complex combination of hydrocarbons produced as the residual fraction from the distillation of heavy coker gas oil and vacuum gas oil. It predominantly consists of hydrocarbons having carbon numbers predominantly greater than C13 and boiling above approximately 230°C (446°F).	86,1	11,7	0,3	0,20	1,220	99,52
098A	64741-66-8	265-068-8	Naphtha (petroleum), light alkylate	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons produced by distillation of the reaction products of isobutane with monoolefinic hydrocarbons usually ranging in carbon numbers from C3 through C5. It consists of predominantly branched chain saturated hydrocarbons having carbon numbers predominantly in the range of C7 through C10 and boiling in the range of approximately 90°C to 160°C (194°F to 320°F).	84,3	15,9				100,20
098B	64741-66-8	265-068-8	Naphtha (petroleum), light alkylate	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons produced by distillation of the reaction products of isobutane with monoolefinic hydrocarbons usually ranging in carbon numbers from C3 through C5. It consists of predominantly branched chain saturated hydrocarbons having carbon numbers predominantly in the range of C7 through C10 and boiling in the range of approximately 90°C to 160°C (194°F to 320°F).	84,2	16,1		0,09		100,39
099	92045-52-8	295-433-7	Naphtha (petroleum), hydrodesulfurized full-range	LOW BOILING POINT NAPHTHAS (GASOLINES)	Inconsistent original description: A complex combination of hydrocarbons obtained from a catalytic hydrodesulfurization process. It consists predominantly of hydrocarbons having carbon numbers predominantly in the range of C4 through C11 and boiling in the range of approximately 30°C to 250°C (86°F to 482°F). CONCAWE substance description: A complex combination of hydrocarbons obtained from a catalytic hydrodesulfurization process. It consists predominantly of hydrocarbons having carbon numbers predominantly in the range of C4 through C11 and boiling in the range of approximately 30°C to 200°C.	85,7	14,5		0,04		100,24

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100	64741-46-4	265-046-8	Naphtha (petroleum), light straight-run	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons produced by distillation of crude oil. It consists predominantly of aliphatic hydrocarbons having carbon numbers predominantly in the range of C4 through C10 and boiling in the range of approximately minus 20°C to 180°C (-4°F to 356°F).	83,7	16,6		0,05	0,017	100,37
101	64742-95-6	265-199-0	Solvent naphtha (petroleum), light arom.	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons obtained from distillation of aromatic streams. It consists predominantly of aromatic hydrocarbons having carbon numbers predominantly in the range of C8 through C10 and boiling in the range of approximately 135°C to 210°C (275°F to 410°F).	89,9	10,0				99,90
102	85116-53-6	285-505-6	Distillates (petroleum), hydrodesulfurized thermal cracked middle	CRACKED GAS OILS	A complex combination of hydrocarbons obtained by fractionation from hydrodesulfurized thermal cracker distillate stocks. It consists predominantly of hydrocarbons having carbon numbers predominantly in the range of C11 to C25 and boiling in the range of approximately 205° C to 400°C (401°F to 752°F).	86,0	12,5	0,2	0,31	0,694	99,70
103	93571-75-6	297-401-8	Aromatic hydrocarbons, C7-12, C8-rich	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons obtained by separation from the platformate-containing fraction. It consists predominantly of aromatic hydrocarbons having carbon numbers predominantly in the range of C7 through C12 (primarily C8) and can contain nonaromatic hydrocarbons, both boiling in the range of approximately 130°C to 200°C (266°F to 392°F).	90,4	9,5				99,90
104	64742-94-5	265-198-5	Solvent naphtha (petroleum), heavy arom.	KEROSINES	A complex combination of hydrocarbons obtained from distillation of aromatic streams. It consists predominantly of aromatic hydrocarbons having carbon numbers predominantly in the range of C9 through C16 and boiling in the range of approximately 165°C to 290°C (330°F to 554°F).	89,7	10,0				99,70
106	64741-60-2	265-062-5	Distillates (petroleum), intermediate catalytic cracked	CRACKED GAS OILS	A complex combination of hydrocarbons produced by the distillation of products from a catalytic cracking process. It consists of hydrocarbons having carbon numbers predominantly in the range of C11 through C30 and boiling in the range of approximately 205°C to 450°C (401°F to 842°F). It contains a relatively large proportion of tricyclic aromatic hydrocarbons.	90,4	9,3	0,2	0,10	0,110	100,11
107	64742-42-3	265-144-0	Hydrocarbon waxes (petroleum), clay-treated microcryst.	PARAFFIN AND HYDROCARBON WAXES	A complex combination of hydrocarbons obtained by treatment of a petroleum microcrystalline wax fraction with natural or modified clay in either a contacting or percolation process to remove the trace amounts of polar compounds and impurities present. It consists predominantly of long branched chain hydrocarbons having carbon numbers predominantly in the range of C25 through C50.	85,5	14,3			0,017	99,82
108	91995-40-3	295-301-9	Distillates (petroleum), dewaxed light paraffinic, hydrotreated	OTHER LUBRICANT BASE OILS	A complex combination of hydrocarbons obtained from an intensive treatment of dewaxed distillate by hydrogenation in the presence of a catalyst. It consists predominantly of saturated hydrocarbons having carbon numbers predominantly in the range of C21 through C29 and produces a finished oil with a viscosity of approximately 13cSt at 50°C.	86,1	13,6			0,079	99,78
109	92045-12-0	295-394-6	Foots oil (petroleum), hydrotreated	FOOTS OILS	No EC number description available in ESIS. CONCAWE substance description: A complex combination of hydrocarbons obtained by hydrotreating the oil fraction obtained from a solvent crystallisation process. It consists predominantly of hydrocarbons having carbon numbers in the range of C20 through C60 and boiling in the range of approximately 350°C to 600°C.	85,7	14,1			0,010	99,81
110	92045-58-4	295-440-5	Naphtha (petroleum), isomerization, C6-fraction	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons obtained by distillation of a gasoline which has been catalytically isomerized. It consists predominantly of hexane isomers boiling in the range of approximately 60°C to 66°C (140°F to 151°F).	84,1	16,2				100,30

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111	92045-77-7	295-459-9	Petrolatum (petroleum), hydrotreated	PETROLATUMS	A complex combination of hydrocarbons obtained as a semi-solid from dewaxed paraffinic residual oil treated with hydrogen in the presence of a catalyst. It consists predominantly of saturated microcrystalline and liquid hydrocarbons having carbon numbers predominantly greater than C20.	85,7	14,1			0,017	99,82
112	94733-15-0	305-594-8	Lubricating oils (petroleum), C18-40, solvent-dewaxed hydrocracked distillate-based	OTHER LUBRICANT BASE OILS	Inconsistent original description: A complex combination of hydrocarbons obtained by solvent deparaffination of the distillation residue from hydrocracked petroleum. It consists predominantly of hydrocarbons having carbon numbers predominantly in the range of C18 through C40 and boiling in the range of approximately 370°C to 550°C (698°F to 1022°F). CONCAWE substance description: A complex combination of hydrocarbons obtained by solvent deparaffination of the distillation residue from hydrocracked petroleum. It consists predominantly of hydrocarbons having carbon numbers predominantly in the range of C18 through C40 and boiling in the range of approximately 300°C to 550°C.	85,8	14,2			0,015	100,02
113	101316-69-2	309-874-0	Lubricating oils (petroleum), C>25, solvent-extd., deasphalted, dewaxed, hydrogenated	OTHER LUBRICANT BASE OILS	A complex combination of hydrocarbons obtained by solvent extraction and hydrogenation of vacuum distillation residues. It consists predominantly of hydrocarbons having carbon numbers predominantly greater than C25 and produces a finished oil with a viscosity in the order of 32cSt to 37cSt at 100°C (212°F).	86,3	13,1	0,1	0,09	0,615	100,21
114	64742-44-5	265-146-1	Distillates (petroleum), clay-treated heavy naphthenic	OTHER LUBRICANT BASE OILS	A complex combination of hydrocarbons resulting from treatment of a petroleum fraction with natural or modified clay in either a contacting or percolation process to remove the trace amounts of polar compounds and impurities present. It consists of hydrocarbons having carbon numbers predominantly in the range of C20 through C50 and produces a finished oil with a viscosity of at least 100 SUS at 100°F (19cSt at 40°C). It contains relatively few normal paraffins.	86,9	12,9		0,04	0,017	99,86
115	72623-85-9	276-736-3	Lubricating oils (petroleum), C20-50, hydrotreated neutral oil-based, high-viscosity	OTHER LUBRICANT BASE OILS	A complex combination of hydrocarbons obtained by treating light vacuum gas oil, heavy vacuum gas oil, and solvent deasphalted residual oil with hydrogen in the presence of a catalyst in a two stage process with dewaxing being carried out between the two stages. It consists predominantly of hydrocarbons having carbon numbers predominantly in the range of C20 through C50 and produces a finished oil having a viscosity of approximately 112cSt at 40°C. It contains a relatively large proportion of saturated hydrocarbons.	86,0	13,9				99,90
116	8032-32-4	232-453-7	Ligroine	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons obtained by the fractional distillation of petroleum. This fraction boils in a range of approximately 20°C to 135°C (58°F to 275°F).	84,0	16,2			0,015	100,22
117	64741-76-0	265-077-7	Distillates (petroleum), heavy hydrocracked	OTHER LUBRICANT BASE OILS	Inconsistent original description: A complex combination of hydrocarbons from the distillation of the products from a hydrocracking process. It consists predominantly of saturated hydrocarbons having carbon numbers in the range of C15-C39 and boiling in the range of approximately 260°C to 600°C (500°F to 1112°F). CONCAWE substance description: A complex combination of hydrocarbons from the distillation of the products from a hydrocracking process. It consists predominantly of hydrocarbons having carbon numbers in the range of C15-C45 and boiling in the range of approximately 260°C to 550°C.	86,8	12,8		0,05	0,108	99,76
118	72623-86-0	276-737-9	Lubricating oils (petroleum), C15-30, hydrotreated neutral oil-based	OTHER LUBRICANT BASE OILS	A complex combination of hydrocarbons obtained by treating light vacuum gas oil and heavy vacuum gas oil with hydrogen in the presence of a catalyst in a two stage process with dewaxing being carried out between the two stages. It consists predominantly of hydrocarbons having carbon numbers predominantly in the range of C15 through C30 and produces a finished oil having a viscosity of approximately 15cSt at 40°C. It contains a relatively large proportion of saturated hydrocarbons.	85,4	14,2				99,60
119	72623-87-1	276-738-4	Lubricating oils (petroleum), C20-50, hydrotreated neutral oil-based	OTHER LUBRICANT BASE OILS	A complex combination of hydrocarbons obtained by treating light vacuum gas oil, heavy vacuum gas oil and solvent deasphalted residual oil with hydrogen in the presence of a catalyst in a two stage process with dewaxing being carried out between the two stages. It consists predominantly of hydrocarbons having carbon numbers predominantly in the range of C20 through C50 and produces a finished oil with a viscosity of approximately 32cSt at 40°C. It contains a relatively large proportion of saturated hydrocarbons.	85,5	14,5				100,00

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120	64741-68-0	265-070-9	Naphtha (petroleum), heavy catalytic reformed	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons produced from the distillation of products from a catalytic reforming process. It consists of predominantly aromatic hydrocarbons having carbon numbers predominantly in the range of C7 through C12 and boiling in the range of approximately 90°C to 230°C (194°F to 446°F).	89,2	10,6				99,80
121	68333-25-5	269-781-5	Distillates (petroleum), hydrodesulfurized light catalytic cracked	CRACKED GAS OILS	A complex combination of hydrocarbons obtained by treating light catalytic cracked distillates with hydrogen to convert organic sulfur to hydrogen sulfide which is removed. It consists of hydrocarbons having carbon numbers predominantly in the range of C9 through C25 and boiling in the range of approximately 150°C to 400°C (302°F to 752°F). It contains a relatively large proportion of bicyclic aromatic hydrocarbons.	86,2	13,7				99,90
122	68919-37-9	272-895-8	Naphtha (petroleum), full-range reformed	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons produced by the distillation of the products from a catalytic reforming process. It consists of hydrocarbons having carbon numbers predominantly in the range of C5 through C12 and boiling in the range of approximately 35°C to 230°C (95°F to 446°F).	88,6	11,4				100,00
123	64742-96-7	265-200-4	Solvent naphtha (petroleum), heavy aliph.	KEROSINES	A complex combination of hydrocarbons obtained from the distillation of crude oil or natural gasoline. It consists predominantly of saturated hydrocarbons having carbon numbers predominantly in the range of C11 through C16 and boiling in the range of approximately 190°C to 290°C (374°F to 554°F).	85,4	13,6		0,04	0,552	99,59
124	68514-79-4	271-058-4	Petroleum products, hydrofiner-powerformer reformates	LOW BOILING POINT NAPHTHAS (GASOLINES)	The complex combination of hydrocarbons obtained in a hydrofiner-powerformer process and boiling in a range of approximately 27°C to 210°C (80°F to 410°F).	90,2	9,9				100,10
125	68783-66-4	272-206-0	Naphtha (petroleum), light, sweetened	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons obtained by subjecting a petroleum distillate to a sweetening process to convert mercaptans or to remove acidic impurities. It consists predominantly of saturated and unsaturated hydrocarbons having carbon numbers predominantly in the range of C3 through C6 and boiling in the range of approximately -20°C to 100°C (-4°F to 212°F).	84,2	16,2				100,40
126	93572-29-3	297-458-9	Gasoline, C5-11, high-octane stabilized reformed	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex high octane combination of hydrocarbons obtained by the catalytic dehydrogenation of a predominantly naphthenic naphtha. It consists predominantly of aromatics and non-aromatics having carbon numbers predominantly in the range of C5 through C11 and boiling in the range of approximately 45°C to 185°C (113°F to 365°F).	89,3	10,5				99,80
127	90669-78-6	292-660-3	Slack wax (petroleum), clay-treated	SLACK WAXES	A complex combination of hydrocarbons obtained by treatment of a petroleum slack wax fraction with natural or modified clay in either a contacting or percolation process. It consists predominantly of saturated straight and branched hydrocarbons having carbon numbers predominantly greater than C20.	85,4	14,5			0,133	100,03
128	91770-15-9	294-799-5	Kerosine (petroleum), sweetened	KEROSINES	A complex combination of hydrocarbons obtained by subjecting a petroleum distillate to a sweetening process to convert mercaptans or to remove acidic impurities. It consists predominantly of hydrocarbons having carbon numbers predominantly in the range of C9 through C16 and boiling in the range of 130°C to 290°C (266°F to 554°F).	85,8	14,1			0,083	99,98
129	93821-66-0	298-754-0	Residual oils (petroleum)	HEAVY FUEL OIL COMPONENTS	A complex combination of hydrocarbons, sulfur compounds and metal-containing organic compounds obtained as the residue from refinery fractionation cracking processes. It produces a finished oil with a viscosity above 2cSt. at 100°C.	87,2	11,2	0,3	0,40	0,747	99,85
130	64741-59-9	265-060-4	Distillates (petroleum), light catalytic cracked	CRACKED GAS OILS	A complex combination of hydrocarbons produced by the distillation of products from a catalytic cracking process. It consists of hydrocarbons having carbon numbers predominantly in the range of C9 through C25 and boiling in the range of approximately 150°C to 400°C (302°F to 752°F). It contains a relatively large proportion of bicyclic aromatic hydrocarbons.	88,5	10,9		0,08	0,293	99,77

Sample Number	CAS Number	EC Number	Substance Name	Category	Substance Description	Carbon (% m/m)	Hydrogen (% m/m)	Nitrogen (% m/m)	Oxygen (% m/m)	Sulphur (% m/m)	Total (% m/m)
131	68955-27-1	273-263-4	Distillates (petroleum), petroleum residues vacuum	HEAVY FUEL OIL COMPONENTS	A complex combination of hydrocarbons produced by the vacuum distillation of the residuum from the atmospheric distillation of crude oil.	87,3	11,4	0,7	0,30	0,527	100,23
132	68476-46-0	270-686-6	Hydrocarbons, C3-11, catalytic cracker distillates	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons produced by the distillations of products from a catalytic cracking process. It consists of hydrocarbons having carbon numbers predominantly in the range of C3 through C11 and boiling in a range approximately up to 204°C(400°F).	86,6	13,5			0,001	100,10
133	64741-64-6	265-066-7	Naphtha (petroleum), full-range alkylate	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons produced by distillation of the reaction products of isobutane with monoolefinic hydrocarbons usually ranging in carbon numbers from C3 through C5. It consists of predominantly branched chain saturated hydrocarbons having carbon numbers predominantly in the range of C7 through C12 and boiling in the range of approximately 90°C to 220°C (194°F to 428°F).	84,4	16,0				100,40
134	64741-61-3	265-063-0	Distillates (petroleum), heavy catalytic cracked	HEAVY FUEL OIL COMPONENTS	A complex combination of hydrocarbons produced by the distillation of products from a catalytic cracking process. It consists of hydrocarbons having carbon numbers predominantly in the range of C15 through C35 and boiling in the range of approximately 260°C to 500°C (500°F to 932°F). This stream is likely to contain 5 wt. % or more of 4- to 6-membered condensed ring aromatic hydrocarbons.	87,5	10,3	0,2	0,10	1,420	99,52
137	90669-74-2	292-656-1	Residual oils (petroleum), hydrotreated solvent dewaxed	OTHER LUBRICANT BASE OILS	No EC number description available in ESIS.	86,2	13,3			0,429	99,93
138	64741-95-3	265-096-0	Residual oils (petroleum), solvent deasphalted	OTHER LUBRICANT BASE OILS	A complex combination of hydrocarbons obtained as the solvent soluble fraction from C3 - C4 solvent deasphalting of a residuum. It consists of hydrocarbons having carbon numbers predominantly higher than C25 and boiling above approximately 400°C (752°F).	85,6	12,7	0,2	0,13	1,430	100,06
139	64742-57-0	265-160-8	Residual oils (petroleum), hydrotreated	OTHER LUBRICANT BASE OILS	A complex combination of hydrocarbons obtained by treating a petroleum fraction with hydrogen in the presence of a catalyst. It consists of hydrocarbons having carbon numbers predominantly greater than C25 and boiling above approximately 400°C (752°F).	86,0	13,2	0,1		0,623	99,92
140	64742-62-7	265-166-0	Residual oils (petroleum), solvent-dewaxed	OTHER LUBRICANT BASE OILS	A complex combination of hydrocarbons obtained by removal of long, branched chain hydrocarbons from a residual oil by solvent crystallization. It consists of hydrocarbons having carbon numbers predominantly greater than C25 and boiling above approximately 400°C (752°F).	85,5	12,7	0,2	0,12	1,540	100,06
141	64741-83-9	265-085-0	Naphtha (petroleum), heavy thermal cracked	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons from distillation of the products from a thermal cracking process. It consists predominantly of unsaturated hydrocarbons having carbon numbers predominantly in the range of C6 through C12 and boiling in the range of approximately 65°C to 220°C (148°F to 428°F).	86,5	13,1		0,07	0,465	100,14
142	64742-49-0	265-151-9	Naphtha (petroleum), hydrotreated light	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons obtained by treating a petroleum fraction with hydrogen in the presence of a catalyst. It consists of hydrocarbons having carbon numbers predominantly in the range of C4 through C11 and boiling in the range of approximately minus 20°C to 190°C (-4°F to 374°F).	84,7	15,6				100,30
143	64741-55-5	265-056-2	Naphtha (petroleum), light catalytic cracked	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons produced by the distillation of products from a catalytic cracking process. It consists of hydrocarbons having carbon numbers predominantly in the range of C4 through C11 and boiling in the range of approximately minus 20°C to 190°C (-4°F to 374°F). It contains a relatively large proportion of unsaturated hydrocarbons.	85,6	14,8			0,001	100,40
144	86290-81-5	289-220-8	Gasoline	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons consisting primarily of paraffins, cycloparaffins, aromatic and olefinic hydrocarbons having carbon numbers predominantly greater than C3 and boiling in the range of 30°C to 260°C (86°F to 500°F).	86,8	13,0		0,04		99,84

Sample Number	CAS Number	EC Number	Substance Name	Category	Substance Description	Carbon (% m/m)	Hydrogen (% m/m)	Nitrogen (% m/m)	Oxygen (% m/m)	Sulphur (% m/m)	Total (% m/m)
145	8042-47-5	232-455-8	White mineral oil (petroleum)	HIGHLY REFINED BASE OILS	A highly refined petroleum mineral oil consisting of a complex combination of hydrocarbons obtained from the intensive treatment of a petroleum fraction with sulfuric acid and oleum, or by hydrogenation, or by a combination of hydrogenation and acid treatment. Additional washing and treating steps may be included in the processing operation. It consists of saturated hydrocarbons having carbon numbers predominantly in the range of C15 through C50.	86,0	14,0				100,00
146	64741-54-4	265-055-7	Naphtha (petroleum), heavy catalytic cracked	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons produced by a distillation of products from a catalytic cracking process. It consists of hydrocarbons having carbon numbers predominantly in the range of C6 through C12 and boiling in the range of approximately 65°C to 230°C (148°F to 446°F). It contains a relatively large proportion of unsaturated hydrocarbons.	87,8	11,8		0,12	0,086	99,81
147	64741-88-4	265-090-8	Distillates (petroleum), solvent-refined heavy paraffinic	OTHER LUBRICANT BASE OILS	A complex combination of hydrocarbons obtained as the raffinate from a solvent extraction process. It consists predominantly of saturated hydrocarbons having carbon numbers predominantly in the range of C20 through C50 and produces a finished oil with a viscosity of at least 100 SUS at 100°F (19cSt at 40°C).	85,7	13,5			0,853	100,05
148	64741-89-5	265-091-3	Distillates (petroleum), solvent-refined light paraffinic	OTHER LUBRICANT BASE OILS	A complex combination of hydrocarbons obtained as the raffinate from a solvent extraction process. It consists predominantly of saturated hydrocarbons having carbon numbers predominantly in the range of C15 through C30 and produces a finished oil with a viscosity of less than 100 SUS at 100°F (19cSt at 40°C).	85,6	13,8			0,545	99,95
149	64742-01-4	265-101-6	Residual oils (petroleum), solvent-refined	OTHER LUBRICANT BASE OILS	A complex combination of hydrocarbons obtained as the solvent insoluble fraction from solvent refining of a residuum using a polar organic solvent such as phenol or furfural. It consists of hydrocarbons having carbon numbers predominantly higher than C25 and boiling above approximately 400°C (752°F).	85,5	13,3			1,040	99,84
150	64742-54-7	265-157-1	Distillates (petroleum), hydrotreated heavy paraffinic	OTHER LUBRICANT BASE OILS	A complex combination of hydrocarbons obtained by treating a petroleum fraction with hydrogen in the presence of a catalyst. It consists of hydrocarbons having carbon numbers predominantly in the range of C20 through C50 and produces a finished oil of at least 100 SUS at 100°F (19cSt at 40°C). It contains a relatively large proportion of saturated hydrocarbons.	86,3	13,5			0,044	99,84
151	64742-55-8	265-158-7	Distillates (petroleum), hydrotreated light paraffinic	OTHER LUBRICANT BASE OILS	A complex combination of hydrocarbons obtained by treating a petroleum fraction with hydrogen in the presence of a catalyst. It consists of hydrocarbons having carbon numbers predominantly in the range of C15 through C30 and produces a finished oil with a viscosity of less than 100 SUS at 100°F (19cSt at 40°C). It contains a relatively large proportion of saturated hydrocarbons.	86,0	13,9		0,05	0,113	100,06
152	64742-61-6	265-165-5	Slack wax (petroleum)	SLACK WAXES	A complex combination of hydrocarbons obtained from a petroleum fraction by solvent crystallization (solvent dewaxing) or as a distillation fraction from a very waxy crude. It consists predominantly of saturated straight and branched chain hydrocarbons having carbon numbers predominantly greater than C20.	85,3	14,5			0,041	99,84
153	64742-70-7	265-174-4	Paraffin oils (petroleum), catalytic dewaxed heavy	OTHER LUBRICANT BASE OILS	A complex combination of hydrocarbons obtained from a catalytic dewaxing process. It consists predominantly of hydrocarbons having carbon numbers predominantly in the range of C20 through C50 and produces a finished oil with a viscosity of at least 100 SUS at 100°F (19cSt at 40°C).	85,4	14,5				99,90
154	64742-71-8	265-176-5	Paraffin oils (petroleum), catalytic dewaxed light	OTHER LUBRICANT BASE OILS	A complex combination of hydrocarbons obtained from a catalytic dewaxing process. It consists predominantly of hydrocarbons having carbon numbers predominantly in the range of C15 through C30 and produces a finished oil with a viscosity of less than 100 SUS at 100°F (19cSt at 40°C).	85,3	14,7		0,06		100,06
155	64741-67-9	265-069-3	Residues (petroleum), catalytic reformer fractionator	HEAVY FUEL OIL COMPONENTS	A complex combination of hydrocarbons produced as the residual fraction from distillation of the product from a catalytic reforming process. It consists of predominantly aromatic hydrocarbons having carbon numbers predominantly in the range of C10 through C25 and boiling in the range of approximately 160°C to 400°C (320°F to 725°F). This stream is likely to contain 5 wt. % or more of 4- or 6-membered condensed ring aromatic hydrocarbons.	90,3	9,4				99,70

Sample Number	CAS Number	EC Number	Substance Name	Category	Substance Description	Carbon (% m/m)	Hydrogen (% m/m)	Nitrogen (% m/m)	Oxygen (% m/m)	Sulphur (% m/m)	Total (% m/m)
156	64742-48-9	265-150-3	Naphtha (petroleum), hydrotreated heavy	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons obtained by treating a petroleum fraction with hydrogen in the presence of a catalyst. It consists of hydrocarbons having carbon numbers predominantly in the range of C6 through C13 and boiling in the range of approximately 65°C to 230°C (149°F to 446°F).	86,0	14,1				100,10
157	64741-63-5	265-065-1	Naphtha (petroleum), light catalytic reformed	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons produced from the distillation of products from a catalytic reforming process. It consists of hydrocarbons having carbon numbers predominantly in the range of C5 through C11 and boiling in the range of approximately 35°C to 190°C (95°F to 374°F). It contains a relatively large proportion of aromatic and branched chain hydrocarbons. This stream may contain 10 vol. % or more benzene.	87,5	12,5				100,00
158	64741-72-6	613-683-0	Naphtha (petroleum), polymn.	LOW BOILING POINT NAPHTHAS (GASOLINES)	No EC number description available in ESIS. A complex combination of hydrocarbons produced by the catalytic polymerization of a mixture rich in propylene or butylene. It consists predominantly of monoolefinic hydrocarbons having carbon numbers predominantly in the range of C6 through C12 and boiling in the range of approximately 65.degree.C to 220.degree.C (148.degree.F to 428.degree.F).	85,6	14,4				100,00
160	93924-32-4	300-226-2	Foots oil (petroleum), clay-treated	FOOTS OILS	A complex combination of hydrocarbons obtained by treatment of Foot's oil with natural or modified clay in either a contacting or percolation process to remove the trace amounts of polar compounds and impurities present. It consists predominantly of branched chain hydrocarbons with carbon numbers predominantly in the range of C20 through C50.	85,6	14,3			0,089	99,99
161	64743-01-7	265-206-7	Petrolatum (petroleum), oxidized	PETROLATUMS	A complex combination of organic compounds, predominantly high molecular weight carboxylic acids, obtained by the air oxidation of petrolatum.	79,3	12,4		8,00	0,092	99,79
162	68410-97-9	270-093-2	Distillates (petroleum), light distillate hydrotreating process, low-boiling	LOW BOILING POINT NAPHTHAS (GASOLINES)	Inconsistent original description: A complex combination of hydrocarbons obtained by the distillation of products from the light distillate hydrotreating process. It consists of hydrocarbons having carbon numbers predominantly in the range of C6 through C9 and boiling in the range of approximately 3°C to 194°C (37°F to 382°F). CONCAWE substance description: A complex combination of hydrocarbons obtained by the distillation of products from the light distillate hydrotreating process. It consists of saturated hydrocarbons having carbon numbers predominantly in the range of C6 through C10 and boiling in the range of approximately 70°C to 180°C.	85,0	15,4				100,40
163	64742-82-1	265-185-4	Naphtha (petroleum), hydrodesulfurized heavy	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons obtained from a catalytic hydrodesulfurization process. It consists of hydrocarbons having carbon numbers predominantly in the range of C7 through C12 and boiling in the range of approximately 90°C to 230°C (194°F to 446°F).	85,2	14,4				99,60
165	64741-70-4	265-073-5	Naphtha (petroleum), isomerization	LOW BOILING POINT NAPHTHAS (GASOLINES)	A complex combination of hydrocarbons obtained from catalytic isomerization of straight chain paraffinic C4 through C6 hydrocarbons. It consists predominantly of saturated hydrocarbons such as isobutane, isopentane, 2,2-dimethylbutane, 2-methylpentane, and 3-methylpentane.	83,7	16,4				100,10
166	64741-75-9	265-076-1	Residues (petroleum), hydrocracked	HEAVY FUEL OIL COMPONENTS	A complex combination of hydrocarbons produced as the residual fraction from distillation of the products of a hydrocracking process. It consists of hydrocarbons having carbon numbers predominantly greater than C20 and boiling above approximately 350°C (662°F).	86,4	13,3			0,001	99,70
168	64741-43-1	265-043-1	Gas oils (petroleum), straight-run	STRAIGHT-RUN GAS OILS	A complex combination of hydrocarbons produced by the distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly in the range of C11 through C25 and boiling in the range of approximately 205°C to 400°C (401°F to 752°F).	85,9	12,8		0,08	1,090	99,87
169	68814-87-9	272-341-5	Distillates (petroleum), full-range straight-run middle	STRAIGHT-RUN GAS OILS	A complex combination of hydrocarbons produced by the distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly in the range of C9 through C25 and boiling in the range of approximately 150°C to 400°C (320°F to 752°F).	85,8	13,1			1,040	99,94
170	68814-87-9	272-341-5	Distillates (petroleum), full-range straight-run middle	STRAIGHT-RUN GAS OILS	A complex combination of hydrocarbons produced by the distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly in the range of C9 through C25 and boiling in the range of approximately 150°C to 400°C (320°F to 752°F).	85,7	13,2		0,08	0,945	99,93

Sample Number	CAS Number	EC Number	Substance Name	Category	Substance Description	Carbon (% m/m)	Hydrogen (% m/m)	Nitrogen (% m/m)	Oxygen (% m/m)	Sulphur (% m/m)	Total (% m/m)
171	68915-96-8	272-817-2	Distillates (petroleum), heavy straight-run	STRAIGHT-RUN GAS OILS	A complex combination of hydrocarbons produced by the atmospheric distillation of crude oil. It boils in the range of approximately 288°C to 471°C (550°F to 880°F).	85,5	12,8		0,06	1,600	99,96
172	64741-43-1	265-043-1	Gas oils (petroleum), straight-run	STRAIGHT-RUN GAS OILS	A complex combination of hydrocarbons produced by the distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly in the range of C11 through C25 and boiling in the range of approximately 205°C to 400°C (401°F to 752°F).	86,5	13,0		0,11	0,234	99,84
173	64742-46-7	265-148-2	Distillates (petroleum), hydrotreated middle	OTHER GAS OILS	A complex combination of hydrocarbons obtained by treating a petroleum fraction with hydrogen in the presence of a catalyst. It consists of hydrocarbons having carbon numbers predominantly in the range of C11 through C25 and boiling in the range of approximately 205°C to 400°C (401°F to 752°F).	86,2	13,4		0,07		99,67
174	64742-80-9	265-183-3	Distillates (petroleum), hydrodesulfurized middle	OTHER GAS OILS	A complex combination of hydrocarbons obtained from a petroleum stock by treating with hydrogen to convert organic sulfur to hydrogen sulfide which is removed. It consists of hydrocarbons having carbon numbers predominantly in the range of C11 through C25 and boiling in the range of approximately 205°C to 400°C (401°F to 752°F).	86,4	13,4		0,04		99,84
175	64741-49-7	265-049-4	Condensates (petroleum), vacuum tower	VACUUM GAS OILS, HYDROCRACKED GAS OILS & DISTILLATE FUELS	A complex combination of hydrocarbons produced as the lowest boiling stream in the vacuum distillation of the residuum from atmospheric distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly in the range of C11 through C25 and boiling in the range of approximately 205°C to 400°C (401°F to 752°F).	86,7	12,9		0,16	0,475	100,24
176	64741-58-8	265-059-9	Gas oils (petroleum), light vacuum	VACUUM GAS OILS, HYDROCRACKED GAS OILS & DISTILLATE FUELS	A complex combination of hydrocarbons produced by the vacuum distillation of the residuum from atmospheric distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly in the range of C13 through C30 and boiling in the range of approximately 230°C to 450°C (446°F to 842°F).	86,8	12,2	0,1	0,30	0,486	99,89
177	64741-77-1	265-078-2	Distillates (petroleum), light hydrocracked	VACUUM GAS OILS, HYDROCRACKED GAS OILS & DISTILLATE FUELS	A complex combination of hydrocarbons from distillation of the products from a hydrocracking process. It consists predominantly of saturated hydrocarbons having carbon numbers predominantly in the range of C10 through C18, and boiling in the range of approximately 160°C to 320°C (320°F to 608°F).	86,6	13,5		0,05		100,15
178	64742-87-6	265-190-1	Gas oils (petroleum), hydrodesulfurized light vacuum	VACUUM GAS OILS, HYDROCRACKED GAS OILS & DISTILLATE FUELS	A complex combination of hydrocarbons obtained from a catalytic hydrodesulfurization process. It consists of hydrocarbons having carbon numbers predominantly in the range of C13 through C30 and boiling in the range of approximately 230°C to 450°C (446°F to 842°F).	87,3	12,8		0,05	0,008	100,16
179	68334-30-5	269-822-7	Fuels, diesel	VACUUM GAS OILS, HYDROCRACKED GAS OILS & DISTILLATE FUELS	A complex combination of hydrocarbons produced by the distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly in the range of C9 through C20 and boiling in the range of approximately 163°C to 357°C (325°F to 675°F).	86,5	13,5		0,06	0,068	100,13
180	68334-30-5	269-822-7	Fuels, diesel	VACUUM GAS OILS, HYDROCRACKED GAS OILS & DISTILLATE FUELS	A complex combination of hydrocarbons produced by the distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly in the range of C9 through C20 and boiling in the range of approximately 163°C to 357°C (325°F to 675°F).	86,1	13,6		0,08	0,003	99,78
181	68476-30-2	270-671-4	Fuel oil, no. 2	VACUUM GAS OILS, HYDROCRACKED GAS OILS & DISTILLATE FUELS	A distillate oil having a minimum viscosity of 32.6 SUS at 37.7°C (100°F) to a maximum of 37.9 SUS at 37.7°C (100°F).	85,9	13,9		0,04	0,138	99,98
182	68476-31-3	270-673-5	Fuel oil, no. 4	VACUUM GAS OILS, HYDROCRACKED GAS OILS & DISTILLATE FUELS	A distillate oil having a minimum viscosity of 45 SUS at 37.7°C (100°F) to a maximum of 125 SUS at 37.7°C (100°F).	85,8	13,0		0,10	1,370	100,27
183	68476-34-6	270-676-1	Fuels, diesel, no. 2	VACUUM GAS OILS, HYDROCRACKED GAS OILS & DISTILLATE FUELS	A distillate oil having a minimum viscosity of 32.6 SUS at 37.7°C (100°F) to a maximum of 40.1 SUS at 37.7°C (100°F).	87,0	12,5		0,09	0,085	99,68

Sample Number	CAS Number	EC Number	Substance Name	Category	Substance Description	Carbon (% m/m)	Hydrogen (% m/m)	Nitrogen (% m/m)	Oxygen (% m/m)	Sulphur (% m/m)	Total (% m/m)
184	92045-24-4	295-407-5	Gas oils (petroleum), hydrotreated light vacuum	VACUUM GAS OILS, HYDROCRACKED GAS OILS & DISTILLATE FUELS	A complex combination of hydrocarbons that is obtained by treatment of light vacuum petroleum gas oils with hydrogen in the presence of a catalyst. It consists of hydrocarbons having carbon numbers predominantly in the range of C13 through C30 and boiling in the range of approximately 230°C to 450°C (446°F to 842°F).	85,9	12,8		0,04	1,320	100,06
185	64742-10-5	265-110-5	Extracts (petroleum), residual oil solvent	RESIDUAL AROMATIC EXTRACTS	A complex combination of hydrocarbons obtained as the extract from a solvent extraction process. It consists predominantly of aromatic hydrocarbons having carbon numbers predominantly higher than C25.	84,9	11,5	0,3	0,40	2,700	99,80
186	91995-70-9	295-332-8	Extracts (petroleum), deasphalted vacuum residue solvent	RESIDUAL AROMATIC EXTRACTS	A complex combination of hydrocarbons obtained by solvent extraction of a vacuum-deasphalted residue. It consists predominantly of aromatic hydrocarbons having carbon numbers predominantly greater than C30. This stream contains more than 5 wt. % of 4- to 6-membered condensed ring aromatic hydrocarbons.	84,4	11,0	0,3	0,40	3,900	100,00
187(1)	64742-79-6	265-182-8	Gas oils (petroleum), hydrodesulfurized	OTHER GAS OILS	A complex combination of hydrocarbons obtained from a petroleum stock by treating with hydrogen to convert organic sulfur to hydrogen sulfide which is removed. It consists predominantly of hydrocarbons having carbon numbers predominantly in the range of C13 through C25 and boiling in the range of approximately 230°C to 400°C (446°F to 752°F).	86,8	13,0		0,06	0,121	99,98
187(2)	64742-79-6	265-182-8	Gas oils (petroleum), hydrodesulfurized	OTHER GAS OILS	A complex combination of hydrocarbons obtained from a petroleum stock by treating with hydrogen to convert organic sulfur to hydrogen sulfide which is removed. It consists predominantly of hydrocarbons having carbon numbers predominantly in the range of C13 through C25 and boiling in the range of approximately 230°C to 400°C (446°F to 752°F).	86,5	13,4		0,04		99,94
188	64741-44-2	265-044-7	Distillates (petroleum), straight-run middle	STRAIGHT-RUN GAS OILS	A complex combination of hydrocarbons produced by the distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly in the range of C11 through C20 and boiling in the range of 205°C to 345°C (401°F to 653°F).	85,7	13,3		0,07	0,958	100,03
189	8052-42-4	232-490-9	Asphalt	BITUMEN	A very complex combination of high molecular weight organic compounds containing a relatively high proportion of hydrocarbons having carbon numbers predominantly greater than C25 with high carbon-to-hydrogen ratios. It also contains small amounts of various metals such as nickel, iron, or vanadium. It is obtained as the non-volatile residue from distillation of crude oil or by separation as the raffinate from a residual oil in a deasphalting or decarbonization process.	83,3	10,1	0,4	0,50	5,580	99,88
190	64741-56-6	265-057-8	Residues (petroleum), vacuum	BITUMEN	A complex residuum from the vacuum distillation of the residuum from atmospheric distillation of crude oil. It consists of hydrocarbons having carbon numbers predominantly greater than C34 and boiling above approximately 495°C (923°F).	85,9	10,8	0,6	0,60	1,840	99,74
191	64742-85-4	265-188-0	Residues (petroleum), hydrodesulfurized vacuum	BITUMEN	A complex combination of hydrocarbons obtained by treating a vacuum residuum with hydrogen in the presence of a catalyst under conditions primarily to remove organic sulfur compounds. It consists of hydrocarbons having carbon numbers predominantly greater than C34 and boiling approximately above 495°C (923°F).	86,2	10,3	0,5	0,40	2,510	99,91
192	92062-05-0	295-518-9	Residues (petroleum), thermal cracked vacuum	BITUMEN	A complex combination of hydrocarbons obtained from the vacuum distillation of the products from a thermal cracking process. It consists predominantly of hydrocarbons having carbon numbers predominantly greater than C34 and boiling above approximately 495°C (923°F).	86,6	9,6	0,7	0,70	2,230	99,83
193	64742-93-4	265-196-4	Asphalt, oxidized	OXIDISED ASPHALT	A complex black solid obtained by blowing air through a heated residuum, or raffinate from a deasphalting process with or without a catalyst. The process is principally one of oxidative condensation which increases the molecular weight.						

Sample Number	CAS Number	EC Number	Substance Name	Category	Substance Description	Carbon (% m/m)	Hydrogen (% m/m)	Nitrogen (% m/m)	Oxygen (% m/m)	Sulphur (% m/m)	Total (% m/m)
195	64742-11-6	265-111-0	Extracts (petroleum), heavy naphthenic distillate solvent	UNTREATED DISTILLATE AROMATIC EXTRACTS	A complex combination of hydrocarbons obtained as the extract from a solvent extraction process. It consists predominantly of aromatic hydrocarbons having carbon numbers predominantly in the range of C20 through C50. This stream is likely to contain 5 wt. % or more of 4- to 6-membered condensed ring aromatic hydrocarbons.	86,4	10,4	0,7	1,00	1,270	99,77
196	100684-33-1	309-706-6	Petrolatum (petroleum), clay-treated	PETROLATUMS	A complex combination of hydrocarbons obtained by treatment of petrolatum with bleaching earth for the removal of traces of polar constituents and impurities. It consists predominantly of hydrocarbons having carbon numbers predominantly in the range of greater than C25.	86,0	14,1		0,30	0,079	100,48
197	64742-59-2	265-162-9	Gas oils (petroleum), hydrotreated vacuum	HEAVY FUEL OIL COMPONENTS	A complex combination of hydrocarbons obtained by treating a petroleum fraction with hydrogen in the presence of a catalyst. It consists of hydrocarbons having carbon numbers predominantly in the range of C13 through C50 and boiling in the range of approximately 230.degree.C to 600.degree.C (446.degree.F to 1112.degree.F). This stream is likely to contain 5 wt. % or more of 4- to 6- membered condensed ring aromatic hydrocarbons.	86,8	13,0	0,1		0,008	99,91
202	92045-76-6	295-458-3	Paraffin waxes and Hydrocarbon waxes, microcryst., hydrotreated	PARAFFIN AND HYDROCARBON WAXES	A complex combination of hydrocarbons obtained from residual oils by solvent crystallisation and treated with hydrogen in the presence of a catalyst. It consists predominantly of saturated straight and branched chain hydrocarbons having carbon numbers predominantly greater than C25.	85,9	14,2			0,003	100,10

Notes

1. Sample numbers are not continuous because some substances were withdrawn by Concawe and other substances were never supplied but analysed by member companies themselves.
2. Blank values for nitrogen represent <0.1% m/m.
3. Blank values for oxygen represent "not detected".
4. Blank values for sulphur represent <0.001% m/m.
5. Total values reported are summations of individually measured values for carbon, hydrogen, nitrogen, oxygen and sulphur; all total values can be rounded to 100% except for Sample 078 (99.48%).

APPENDIX 1 - UV SPECTRAL DATA

Bitumen
UV-VIS_189 pdf file
UV-VIS_190 pdf file
UV-VIS_191 pdf file
UV-VIS_192 pdf file

Cracked Gas Oils
UV-VIS_003 pdf file
UV-VIS_012 pdf file
UV-VIS_041 pdf file
UV-VIS_070 pdf file
UV-VIS_102 pdf file
UV-VIS_106 pdf file
UV-VIS_121 pdf file
UV-VIS_130 pdf file

Foots Oils
UV-VIS_090 pdf file
UV-VIS_109 pdf file
UV-VIS_160 pdf file

Heavy Fuel Oils
UV-VIS_006 pdf file
UV-VIS_007 pdf file
UV-VIS_008 pdf file
UV-VIS_017 pdf file
UV-VIS_018 pdf file
UV-VIS_020 pdf file
UV-VIS_021 pdf file
UV-VIS_025 pdf file
UV-VIS_028 pdf file
UV-VIS_031 pdf file
UV-VIS_034 pdf file
UV-VIS_050 pdf file
UV-VIS_058 pdf file
UV-VIS_071 pdf file
UV-VIS_078 pdf file
UV-VIS_079 pdf file
UV-VIS_080 pdf file
UV-VIS_091 pdf file
UV-VIS_097 pdf file
UV-VIS_129 pdf file
UV-VIS_131 pdf file
UV-VIS_134 pdf file
UV-VIS_155 pdf file
UV-VIS_166 pdf file
UV-VIS_197 pdf file

Highly Refined Base Oils
UV-VIS_145 pdf file

Kerosines

UV-VIS_011 pdf file
UV-VIS_016 pdf file
UV-VIS_043 pdf file
UV-VIS_049 pdf file
UV-VIS_086 pdf file
UV-VIS_087 pdf file
UV-VIS_104 pdf file
UV-VIS_123 pdf file
UV-VIS_128 pdf file

Low Boiling Point Naphthas

UV-VIS_001 pdf file
UV-VIS_002 pdf file
UV-VIS_004 pdf file
UV-VIS_009 pdf file
UV-VIS_010 pdf file
UV-VIS_013 pdf file
UV-VIS_014 pdf file
UV-VIS_015 pdf file
UV-VIS_019 pdf file
UV-VIS_022 pdf file
UV-VIS_023 pdf file
UV-VIS_026 pdf file
UV-VIS_027 pdf file
UV-VIS_029 pdf file
UV-VIS_030 pdf file
UV-VIS_033 pdf file
UV-VIS_035 pdf file
UV-VIS_037 pdf file
UV-VIS_038 pdf file
UV-VIS_039 pdf file
UV-VIS_040 pdf file
UV-VIS_042 pdf file
UV-VIS_044 pdf file
UV-VIS_045 pdf file
UV-VIS_046 pdf file
UV-VIS_047 pdf file
UV-VIS_048 pdf file
UV-VIS_052 pdf file
UV-VIS_053 pdf file
UV-VIS_054 pdf file
UV-VIS_055 pdf file
UV-VIS_056 pdf file
UV-VIS_057 pdf file
UV-VIS_068 pdf file
UV-VIS_076 pdf file
UV-VIS_077 pdf file
UV-VIS_094 pdf file
UV-VIS_095 pdf file
UV-VIS_098A pdf file
UV-VIS_098B pdf file
UV-VIS_099 pdf file
UV-VIS_100 pdf file
UV-VIS_101 pdf file
UV-VIS_103 pdf file

UV-VIS_110 pdf file
UV-VIS_116 pdf file
UV-VIS_120 pdf file
UV-VIS_122 pdf file
UV-VIS_124 pdf file
UV-VIS_125 pdf file
UV-VIS_126 pdf file
UV-VIS_132 pdf file
UV-VIS_133 pdf file
UV-VIS_141 pdf file
UV-VIS_142 pdf file
UV-VIS_143 pdf file
UV-VIS_144 pdf file
UV-VIS_146 pdf file
UV-VIS_156 pdf file
UV-VIS_157 pdf file
UV-VIS_158 pdf file
UV-VIS_162 pdf file
UV-VIS_163 pdf file
UV-VIS_165 pdf file

Mk1 Diesel Fuel
UV-VIS_059 pdf file

Other Gas Oils
UV-VIS_173 pdf file
UV-VIS_174 pdf file
UV-VIS_187(1) pdf file
UV-VIS_187(2) pdf file

Other Lubricant Base Oils
UV-VIS_036 pdf file
UV-VIS_060 pdf file
UV-VIS_066 pdf file
UV-VIS_072 pdf file
UV-VIS_073 pdf file
UV-VIS_074 pdf file
UV-VIS_075 pdf file
UV-VIS_081 pdf file
UV-VIS_085A pdf file
UV-VIS_085B pdf file
UV-VIS_085C pdf file
UV-VIS_085D pdf file
UV-VIS_092 pdf file
UV-VIS_112 pdf file
UV-VIS_113 pdf file
UV-VIS_114 pdf file
UV-VIS_115 pdf file
UV-VIS_117 pdf file
UV-VIS_118 pdf file
UV-VIS_119 pdf file
UV-VIS_137 pdf file
UV-VIS_138 pdf file
UV-VIS_139 pdf file
UV-VIS_140 pdf file
UV-VIS_147 pdf file

UV-VIS_148 pdf file
UV-VIS_149 pdf file
UV-VIS_150 pdf file
UV-VIS_151 pdf file
UV-VIS_153 pdf file
UV-VIS_154 pdf file

Oxidised Asphalt
UV-VIS_193 pdf file

Paraffin and Hydrocarbon Waxes
UV-VIS_061 pdf file
UV-VIS_062 pdf file
UV-VIS_063 pdf file
UV-VIS_065 pdf file
UV-VIS_067 pdf file
UV-VIS_107 pdf file
UV-VIS_202 pdf file

Petrolatums
UV-VIS_093 pdf file
UV-VIS_111 pdf file
UV-VIS_161 pdf file
UV-VIS_196 pdf file

Residual Aromatic Extracts
UV-VIS_185 pdf file
UV-VIS_186 pdf file

Slack Waxes
UV-VIS_127 pdf file
UV-VIS_152 pdf file

Straight-Run Gas Oils
UV-VIS_168 pdf file
UV-VIS_169 pdf file
UV-VIS_170 pdf file
UV-VIS_171 pdf file
UV-VIS_172 pdf file
UV-VIS_188 pdf file

Treated Distillate Aromatic Extracts
UV-VIS_069 pdf file

Unrefined / Acid Treated Oils
UV-VIS_064 pdf file
UV-VIS_082 pdf file
UV-VIS_083 pdf file
UV-VIS_084 pdf file

Untreated Distillate Aromatic Extracts
UV-VIS_089 pdf file
UV-VIS_195 pdf file

Vacuum Gas Oils, Hydrocracked Gas Oils and Distillate Fuels
UV-VIS_175 pdf file
UV-VIS_176 pdf file
UV-VIS_177 pdf file
UV-VIS_178 pdf file
UV-VIS_179 pdf file
UV-VIS_180 pdf file
UV-VIS_181 pdf file
UV-VIS_182 pdf file
UV-VIS_183 pdf file
UV-VIS_184 pdf file

APPENDIX 2 - IR SPECTRAL DATA

Bitumen
IR_189 pdf file
IR_190 pdf file
IR_191 pdf file
IR_192 pdf file

Cracked Gas Oils
IR_003 pdf file
IR_012 pdf file
IR_041 pdf file
IR_070 pdf file
IR_102 pdf file
IR_106 pdf file
IR_121 pdf file
IR_130 pdf file

Foots Oils
IR_090 pdf file
IR_109 pdf file
IR_160 pdf file

Heavy Fuel Oils
IR_006 pdf file
IR_007 pdf file
IR_008 pdf file
IR_017 pdf file
IR_018 pdf file
IR_020 pdf file
IR_021 pdf file
IR_025 pdf file
IR_028 pdf file
IR_031 pdf file
IR_034 pdf file
IR_050 pdf file
IR_058 pdf file
IR_071 pdf file
IR_078 pdf file
IR_079 pdf file
IR_080 pdf file
IR_091 pdf file
IR_097 pdf file
IR_129 pdf file
IR_131 pdf file
IR_134 pdf file
IR_155 pdf file
IR_166 pdf file
IR_197 pdf file

Highly Refined Base Oils
IR_145 pdf file

Kerosines

IR_011 pdf file
IR_016 pdf file
IR_043 pdf file
IR_049 pdf file
IR_086 pdf file
IR_087 pdf file
IR_104 pdf file
IR_123 pdf file
IR_128 pdf file

Low Boiling Point Naphthas

IR_001 pdf file
IR_002 pdf file
IR_004 pdf file
IR_009 pdf file
IR_010 pdf file
IR_013 pdf file
IR_014 pdf file
IR_015 pdf file
IR_019 pdf file
IR_022 pdf file
IR_023 pdf file
IR_026 pdf file
IR_027 pdf file
IR_029 pdf file
IR_030 pdf file
IR_033 pdf file
IR_035 pdf file
IR_037 pdf file
IR_038 pdf file
IR_039 pdf file
IR_040 pdf file
IR_042 pdf file
IR_044 pdf file
IR_045 pdf file
IR_046 pdf file
IR_047 pdf file
IR_048 pdf file
IR_052 pdf file
IR_053 pdf file
IR_054 pdf file
IR_055 pdf file
IR_056 pdf file
IR_057 pdf file
IR_068 pdf file
IR_076 pdf file
IR_077 pdf file
IR_094 pdf file
IR_095 pdf file
IR_098A pdf file
IR_098B pdf file
IR_099 pdf file
IR_100 pdf file
IR_101 pdf file
IR_103 pdf file

IR_110 pdf file
IR_116 pdf file
IR_120 pdf file
IR_122 pdf file
IR_124 pdf file
IR_125 pdf file
IR_126 pdf file
IR_132 pdf file
IR_133 pdf file
IR_141 pdf file
IR_142 pdf file
IR_143 pdf file
IR_144 pdf file
IR_146 pdf file
IR_156 pdf file
IR_157 pdf file
IR_158 pdf file
IR_162 pdf file
IR_163 pdf file
IR_165 pdf file

Mk1 Diesel Fuel

IR_059 pdf file

Other Gas Oils

IR_173 pdf file
IR_174 pdf file
IR_187(1) pdf file
IR_187(2) pdf file

Other Lubricant Base Oils

IR_036 pdf file
IR_060 pdf file
IR_066 pdf file
IR_072 pdf file
IR_073 pdf file
IR_074 pdf file
IR_075 pdf file
IR_081 pdf file
IR_085A pdf file
IR_085B pdf file
IR_085C pdf file
IR_085D pdf file
IR_092 pdf file
IR_108 pdf file
IR_112 pdf file
IR_113 pdf file
IR_114 pdf file
IR_115 pdf file
IR_117 pdf file
IR_118 pdf file
IR_119 pdf file
IR_137 pdf file
IR_138 pdf file
IR_139 pdf file
IR_140 pdf file

IR_147 pdf file
IR_148 pdf file
IR_149 pdf file
IR_150 pdf file
IR_151 pdf file
IR_153 pdf file
IR_154 pdf file

Oxidised Asphalt
IR_193 pdf file

Paraffin and Hydrocarbon Waxes
IR_061 pdf file
IR_062 pdf file
IR_063 pdf file
IR_065 pdf file
IR_067 pdf file
IR_107 pdf file
IR_202 pdf file

Petrolatums
IR_093 pdf file
IR_111 pdf file
IR_161 pdf file
IR_196 pdf file

Residual Aromatic Extracts
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IR_152 pdf file

Straight-Run Gas Oils
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IR_169 pdf file
IR_170 pdf file
IR_171 pdf file
IR_172 pdf file
IR_188 pdf file

Treated Distillate Aromatic Extracts
IR_069 pdf file

Unrefined / Acid Treated Oils
IR_064 pdf file
IR_082 pdf file
IR_083 pdf file
IR_084 pdf file

Untreated Distillate Aromatic Extracts
IR_089 pdf file
IR_096A pdf file
IR_096B pdf file
IR_195 pdf file

Vacuum Gas Oils, Hydrocracked Gas Oils and Distillate Fuels
IR_175 pdf file
IR_176 pdf file
IR_177 pdf file
IR_178 pdf file
IR_179 pdf file
IR_180 pdf file
IR_181 pdf file
IR_182 pdf file
IR_183 pdf file
IR_184 pdf file

APPENDIX 3 - ^{1}H-NMR SPECTRAL DATA

Bitumen
^{1}HNMR_189 pdf file
^{1}HNMR_190 pdf file
^{1}HNMR_191 pdf file
^{1}HNMR_192 pdf file

Cracked Gas Oils
^{1}HNMR_003 pdf file
^{1}HNMR_012 pdf file
^{1}HNMR_041 pdf file
^{1}HNMR_070 pdf file
^{1}HNMR_102 pdf file
^{1}HNMR_106 pdf file
^{1}HNMR_121 pdf file
^{1}HNMR_130 pdf file

Foots Oils
^{1}HNMR_090 pdf file
^{1}HNMR_109 pdf file
^{1}HNMR_160 pdf file

Heavy Fuel Oils
^{1}HNMR_006 pdf file
^{1}HNMR_007 pdf file
^{1}HNMR_008 pdf file
^{1}HNMR_017 pdf file
^{1}HNMR_018 pdf file
^{1}HNMR_020 pdf file
^{1}HNMR_021 pdf file
^{1}HNMR_025 pdf file
^{1}HNMR_028 pdf file
^{1}HNMR_031 pdf file
^{1}HNMR_034 pdf file
^{1}HNMR_050 pdf file
^{1}HNMR_058 pdf file
^{1}HNMR_071 pdf file
^{1}HNMR_078 pdf file
^{1}HNMR_079 pdf file
^{1}HNMR_080 pdf file
^{1}HNMR_091 pdf file
^{1}HNMR_097 pdf file
^{1}HNMR_129 pdf file
^{1}HNMR_131 pdf file
^{1}HNMR_134 pdf file
^{1}HNMR_155 pdf file
^{1}HNMR_166 pdf file
^{1}HNMR_197 pdf file

Highly Refined Base Oils
^{1}HNMR_145 pdf file

Kerosines

[1]HNMR_011 pdf file
[1]HNMR_016 pdf file
[1]HNMR_043 pdf file
[1]HNMR_049 pdf file
[1]HNMR_086 pdf file
[1]HNMR_087 pdf file
[1]HNMR_104 pdf file
[1]HNMR_123 pdf file
[1]HNMR_128 pdf file

Low Boiling Point Naphthas

[1]HNMR_001 pdf file
[1]HNMR_002 pdf file
[1]HNMR_004 pdf file
[1]HNMR_009 pdf file
[1]HNMR_010 pdf file
[1]HNMR_013 pdf file
[1]HNMR_014 pdf file
[1]HNMR_015 pdf file
[1]HNMR_019 pdf file
[1]HNMR_022 pdf file
[1]HNMR_023 pdf file
[1]HNMR_026 pdf file
[1]HNMR_027 pdf file
[1]HNMR_029 pdf file
[1]HNMR_030 pdf file
[1]HNMR_033 pdf file
[1]HNMR_035 pdf file
[1]HNMR_037 pdf file
[1]HNMR_038 pdf file
[1]HNMR_039 pdf file
[1]HNMR_040 pdf file
[1]HNMR_042 pdf file
[1]HNMR_044 pdf file
[1]HNMR_045 pdf file
[1]HNMR_046 pdf file
[1]HNMR_047 pdf file
[1]HNMR_048 pdf file
[1]HNMR_052 pdf file
[1]HNMR_053 pdf file
[1]HNMR_054 pdf file
[1]HNMR_055 pdf file
[1]HNMR_056 pdf file
[1]HNMR_057 pdf file
[1]HNMR_068 pdf file
[1]HNMR_076 pdf file
[1]HNMR_077 pdf file
[1]HNMR_094 pdf file
[1]HNMR_095 pdf file
[1]HNMR_098A pdf file
[1]HNMR_098B pdf file
[1]HNMR_099 pdf file
[1]HNMR_100 pdf file
[1]HNMR_101 pdf file
[1]HNMR_103 pdf file

[1]HNMR_110 pdf file
[1]HNMR_116 pdf file
[1]HNMR_120 pdf file
[1]HNMR_122 pdf file
[1]HNMR_124 pdf file
[1]HNMR_125 pdf file
[1]HNMR_126 pdf file
[1]HNMR_132 pdf file
[1]HNMR_133 pdf file
[1]HNMR_141 pdf file
[1]HNMR_142 pdf file
[1]HNMR_143 pdf file
[1]HNMR_144 pdf file
[1]HNMR_146 pdf file
[1]HNMR_156 pdf file
[1]HNMR_157 pdf file
[1]HNMR_158 pdf file
[1]HNMR_162 pdf file
[1]HNMR_163 pdf file
[1]HNMR_165 pdf file

Mk1 Diesel Fuel
[1]HNMR_059 pdf file

Other Gas Oils
[1]HNMR_173 pdf file
[1]HNMR_174 pdf file
[1]HNMR_187(1) pdf file
[1]HNMR_187(2) pdf file

Other Lubricant Base Oils
[1]HNMR_036 pdf file
[1]HNMR_060 pdf file
[1]HNMR_066 pdf file
[1]HNMR_072 pdf file
[1]HNMR_073 pdf file
[1]HNMR_074 pdf file
[1]HNMR_075 pdf file
[1]HNMR_081 pdf file
[1]HNMR_085A pdf file
[1]HNMR_085B pdf file
[1]HNMR_085C pdf file
[1]HNMR_085D pdf file
[1]HNMR_092 pdf file
[1]HNMR_112 pdf file
[1]HNMR_113 pdf file
[1]HNMR_114 pdf file
[1]HNMR_115 pdf file
[1]HNMR_117 pdf file
[1]HNMR_118 pdf file
[1]HNMR_119 pdf file
[1]HNMR_137 pdf file
[1]HNMR_138 pdf file
[1]HNMR_139 pdf file
[1]HNMR_140 pdf file
[1]HNMR_147 pdf file

[1]HNMR_148 pdf file
[1]HNMR_149 pdf file
[1]HNMR_150 pdf file
[1]HNMR_151 pdf file
[1]HNMR_153 pdf file
[1]HNMR_154 pdf file

Oxidised Asphalt
[1]HNMR_193 pdf file

Paraffin and Hydrocarbon Waxes
[1]HNMR_061 pdf file
[1]HNMR_062 pdf file
[1]HNMR_063 pdf file
[1]HNMR_065 pdf file
[1]HNMR_067 pdf file
[1]HNMR_107 pdf file
[1]HNMR_202 pdf file

Petrolatums
[1]HNMR_093 pdf file
[1]HNMR_111 pdf file
[1]HNMR_161 pdf file
[1]HNMR_196 pdf file

Residual Aromatic Extracts
[1]HNMR_185 pdf file
[1]HNMR_186 pdf file

Slack Waxes
[1]HNMR_127 pdf file
[1]HNMR_152 pdf file

Straight-Run Gas Oils
[1]HNMR_168 pdf file
[1]HNMR_169 pdf file
[1]HNMR_170 pdf file
[1]HNMR_171 pdf file
[1]HNMR_172 pdf file
[1]HNMR_188 pdf file

Treated Distillate Aromatic Extracts
[1]HNMR_069 pdf file

Unrefined / Acid Treated Oils
[1]HNMR_064 pdf file
[1]HNMR_082 pdf file
[1]HNMR_083 pdf file
[1]HNMR_084 pdf file

Untreated Distillate Aromatic Extracts
[1]HNMR_089 pdf file
[1]HNMR_096A pdf file
[1]HNMR_096B pdf file
[1]HNMR_195 pdf file

Vacuum Gas Oils, Hydrocracked Gas Oils and Distillate Fuels

^{1}HNMR_175 pdf file
^{1}HNMR_176 pdf file
^{1}HNMR_177 pdf file
^{1}HNMR_178 pdf file
^{1}HNMR_179 pdf file
^{1}HNMR_180 pdf file
^{1}HNMR_181 pdf file
^{1}HNMR_182 pdf file
^{1}HNMR_183 pdf file
^{1}HNMR_184 pdf file

APPENDIX 4 - ^{13}C-NMR SPECTRAL DATA

Bitumen

^{13}CNMR_189 pdf file
^{13}CNMR_190 pdf file
^{13}CNMR_191 pdf file
^{13}CNMR_192 pdf file

Cracked Gas Oils

^{13}CNMR_003 pdf file
^{13}CNMR_012 pdf file
^{13}CNMR_041 pdf file
^{13}CNMR_070 pdf file
^{13}CNMR_102 pdf file
^{13}CNMR_106 pdf file
^{13}CNMR_121 pdf file
^{13}CNMR_130 pdf file

Foots Oils

^{13}CNMR_090 pdf file
^{13}CNMR_109 pdf file
^{13}CNMR_160 pdf file

Heavy Fuel Oils

^{13}CNMR_006 pdf file
^{13}CNMR_007 pdf file
^{13}CNMR_008 pdf file
^{13}CNMR_017 pdf file
^{13}CNMR_018 pdf file
^{13}CNMR_020 pdf file
^{13}CNMR_021 pdf file
^{13}CNMR_025 pdf file
^{13}CNMR_028 pdf file
^{13}CNMR_031 pdf file
^{13}CNMR_034 pdf file
^{13}CNMR_050 pdf file
^{13}CNMR_058 pdf file
^{13}CNMR_071 pdf file
^{13}CNMR_078 pdf file
^{13}CNMR_079 pdf file
^{13}CNMR_080 pdf file
^{13}CNMR_091 pdf file
^{13}CNMR_097 pdf file
^{13}CNMR_129 pdf file
^{13}CNMR_131 pdf file
^{13}CNMR_134 pdf file
^{13}CNMR_155 pdf file
^{13}CNMR_166 pdf file
^{13}CNMR_197 pdf file

Highly Refined Base Oils

^{13}CNMR_145 pdf file

Kerosines

^{13}CNMR_011 pdf file
^{13}CNMR_016 pdf file
^{13}CNMR_043 pdf file
^{13}CNMR_049 pdf file
^{13}CNMR_086 pdf file
^{13}CNMR_087 pdf file
^{13}CNMR_104 pdf file
^{13}CNMR_123 pdf file
^{13}CNMR_128 pdf file

Low Boiling Point Naphthas

^{13}CNMR_001 pdf file
^{13}CNMR_002 pdf file
^{13}CNMR_004 pdf file
^{13}CNMR_009 pdf file
^{13}CNMR_010 pdf file
^{13}CNMR_013 pdf file
^{13}CNMR_014 pdf file
^{13}CNMR_015 pdf file
^{13}CNMR_019 pdf file
^{13}CNMR_022 pdf file
^{13}CNMR_023 pdf file
^{13}CNMR_026 pdf file
^{13}CNMR_027 pdf file
^{13}CNMR_029 pdf file
^{13}CNMR_030 pdf file
^{13}CNMR_033 pdf file
^{13}CNMR_035 pdf file
^{13}CNMR_037 pdf file
^{13}CNMR_038 pdf file
^{13}CNMR_039 pdf file
^{13}CNMR_040 pdf file
^{13}CNMR_042 pdf file
^{13}CNMR_044 pdf file
^{13}CNMR_045 pdf file
^{13}CNMR_046 pdf file
^{13}CNMR_047 pdf file
^{13}CNMR_048 pdf file
^{13}CNMR_052 pdf file
^{13}CNMR_053 pdf file
^{13}CNMR_054 pdf file
^{13}CNMR_055 pdf file
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