

**Abstract: Hydrocarbon Characterization for Use in the Hydrocarbon Risk Calculator
and Example Characterizations of Selected Alaskan Fuels
Technical Background Document and Recommendations**

Petroleum hydrocarbon fuels are complex mixtures consisting of hundreds of compounds with properties such as solubility, vapor pressure, and toxicity ranging over several orders of magnitude. Understanding the character of Alaskan fuels and the change in properties in the soil environment is critical when assessing the risk posed by spilled fuels and the remediation of spilled fuels. The document presents:

- A brief description of the in-state refineries, and the types and volumes of fuels used in Alaska
- A summary of hydrocarbon phase partitioning; a description of the aromatic and aliphatic equivalent carbon characterization of fuels
- Hydrocarbon fractions recommended for characterizing Alaskan fuels for risk calculations
- Results of the laboratory analysis of 12 typical Alaskan gasoline, jet and diesel fuels

A review of petroleum hydrocarbon phase partitioning highlights the quantitative relationship between the dissolved, vapor, and adsorbed phases and introduces the concept of the “soil saturation concentration” (which is the soils capacity to hold hydrocarbons in the dissolved, vapor, and adsorbed phases). At hydrocarbon concentrations below the soil saturation concentration, all hydrocarbon present in the soil is distributed among the dissolved, vapor, and adsorbed phases and may be referred to as a three-phase problem. At hydrocarbon concentrations above the soil saturation concentration, non-aqueous phase hydrocarbon (NAPL or free product) is present in addition to the dissolved, vapor, and adsorbed phases, and the distribution of hydrocarbon may be referred to as a four-phase problem. When a multi-constituent NAPL is present, the solubility and vapor pressure of individual compounds is a function of their mole fractions in the NAPL, as described by Raoult’s Law. Calculation of the soil saturation concentration for representative fuel hydrocarbons shows that NAPL is typically present at the lowest ADEC Table B2 concentrations; therefore, four-phase partitioning equations should be used to more accurately characterize risks posed by the fuel hydrocarbons at regulated sites. The current 18 AAC 75 Table B1 and B2 values, which assume three-phase partitioning and do not apply Raoult’s Law, commonly overestimate the risk associated with vapor inhalation and migration-to-groundwater routes by a factor of 10 to more than 100.

The fuel hydrocarbon characterization recommended for risk calculations is based on the Total Petroleum Hydrocarbon Criteria Working Group publications and includes five GRO aromatic fractions (BTEX compounds plus the C9 to C10 aromatics); three GRO aliphatic fractions; three DRO aromatic fractions; three DRO aliphatic fractions, and one each RRO aromatic and aliphatic fractions. In addition, 13 PAH compounds are included in the risk calculations. These hydrocarbon fractions or groups were selected to represent both the more-mobile, higher-risk compounds and the bulk hydrocarbon.

Samples of 12 Alaskan fuels were analyzed to demonstrate the use of the aromatic and aliphatic equivalent carbon groups, to improve the general understanding of commonly used Alaskan fuels and potentially for use in the four-phase calculator when site-specific data are not available. The analysis suggests that the diesel samples consisted of about 20% aromatics and 80% aliphatics and that diesel-range effective solubilities are on the order of 1 to 5 mg/L.