3. CHEMICAL AND PHYSICAL INFORMATION

3.1 CHEMICAL IDENTITY

Information regarding the chemical identities of JP-5 and JP-8 is located in Table 3- 1. Information on the composition of jet fuel no. 1 (kerosene) and JP-5 is presented in Table 3-2. Information on the composition of JP-8 is presented in Table 3-3.

Both JP-5 and JP-8 are distillate fuels consisting of distilled process streams refined from crude petroleum. Characteristics of JP-8 fuel (such as density and distillation temperatures) are very similar to those of JP-5 (DOD 1992). There is no standard formula for jet fuels. Their exact composition depends on the crude oil from which they were refined. Variability in fuel composition occurs because of differences in the original crude oil (Custance et al. 1992; IARC 1989) and in the individual additives. As a result of this variability, little information exists on the exact chemical and physical properties of jet fuels (Custance et al. 1992). However, the differences in these fuels are minor. The primary ingredient of both JP-5 and JP-8 is kerosene, and the composition of these fuels is basically the same as kerosene, with the exceptions that they are made under more stringent conditions and contain various additives not found in kerosene (DOD 1992; IARC 1989). The crude oil from which JP-5 and JP-8 are refined is derived from petroleum, tar sands, oil shale, or mixtures thereof (DOD 1992). Typical additives to JP-5 and JP-8 include antioxidants (including phenolic antioxidants), static inhibitors, corrosion inhibitors, fuel system icing inhibitors, lubrication improvers, biocides, and thermal stability improvers (DOD 1992; IARC 1989; Pearson 1988). These additives are used only in specified amounts, as governed by military specifications (DOD 1992; IARC 1989). Straight-run kerosene, the basic component of the kerosene used for jet fuels, consists of hydrocarbons with carbon numbers mostly in the C_9–C_{16} range. Like all jet fuels, straight-run kerosene consists of a complex mixture of aliphatic and aromatic hydrocarbons (LARC 1989). Aliphatic alkanes (paraffins) and cycloalkanes (naphthenes) are hydrogen saturated, clean burning, and chemically stable and together constitute the major part of kerosene (IARC 1989). Aromatics comprise lo-20% and olefins less than 1% of the jet fuels (JARC 1989). The boiling range of kerosene, JP-5, and JP-8 is well above the boiling point of benzene (a carcinogenic aromatic) and many polycyclic aromatic hydrocarbons (PAHs); consequently, the benzene content of kerosene and these jet fuels is normally below 0.02%, and PAHs are virtually excluded (IARC 1989).

TABLE 3-1. Chemical Identity of JP-5 & JP-8

Characteristic	JP-5	JP-8
Synonym(s)	NATO F-44; AVCAT; MIL-T-5624M; aviation kerosene; kerosene; fuel oil no. 1; jet kerosine; turbo fuel A; straight run kerosene; distillate fuel oils, light[a,b,c,d]	NATO F-34; AVTUR; MIL-T-83133B; aviation kerosene; kerosene; fuel oil no. 1; jet kerosine; turbo fuel A; straight run kerosene; distillate fuel oils, light[a,b,c,d]
Registered trade name(s)	No data	No data
Chemical formula[e]	No data	No data
Chemical structure[e]	No data	No data
Identification numbers:		
CAS registry	8008-20-6[f]/70892-10-3[g]	8008-20-6[b]/70892-10-3[g]
NIOSH RTECS	OA5500000[b] (kerosene)	OA5500000[b] (kerosene)
EPA hazardous waste	No data	No data
OHM/TADS	7217063[g] (kerosene)	7217063[g] (kerosene)
DOT/UN/NA/IMCO shipping	UN 1223; IMO 3.3[b] (kerosene)	UN 1223; IMO 3.3[b] (kerosene)
HSDB	632[b]	632[b] (kerosene)
NCI	No data	No data

[a]RTECS 1998
[b]HSDB 1998
[c]IARC 1989
[d]Army 1988
[e]Fuel oils are mixtures of various hydrocarbons designed to meet specifications set forth by the American Society for Testing and Materials (DOD 1992); therefore, chemical structure and chemical formula cannot be determined.
[f]NTP/NIH 1986
[g]OHM/TADS 1985

CAS = Chemical Abstracts Services; DOT/UN/NA/IMCO = Department of Transportation/United Nations/North America/International Maritime Dangerous Goods Code; EPA = Environmental Protection Agency; HSDB = Hazardous Substances Data Bank; NCI = National Cancer Institute; NIOSH = National Institute for Occupational Safety and Health; OHM/TADS = Oil and Hazardous Materials/Technical Assistance Data System; RTECS = Registry of Toxic Effects of Chemical Substances

TABLE 3-2. Analysis of Fuel Oil No. 1 and JP-5

	Volume %	
Hydrocarbon type	Fuel oil no. 1[a]	JP-5[b]
Paraffins (*n*- and iso-)	52.4	30.8
Monocycloparaffins	21.3	No data
Bicycloparaffins	5.1	No data
Tricycloparaffins	0.8	No data
Total cycloparaffins	27.2	52.8
Total saturated hydrocarbons	79.7	No data
Olefins	No data	0.5
Alkylbenzenes	13.5	No data
Indans/tetralins	3.3	No data
Dinaphthenobenzenes/indenes	0.9	No data
Naphthalenes	2.8	No data
Biphenyls/acenaphthenes	0.4	No data
Fluorenes/acenaphthylenes	No data	No data
Phenanthrenes	No data	No data
Total aromatic hydrocarbons	23.6	15.9

[a]Derived from IARC 1989; provided by the American Petroleum Institute
[b]Derived from sample lot used in NTP/NIH 1986 study

TABLE 3-3. Composition of Surrogate JP-8[a]

Hydrocarbon type	Weight %
Isooctane	3.66
Methylcyclohexane	3.51
m-Xylene	3.95
Cyclooctane	4.54
Decane	16.08
Butylbenzene	4.72
1,2,4,5-Tetramethylbenzene	4.28
Tetralin	4.14
Dodecane	22.54
1-Methylnaphthalene	3.49
Tetradecane	16.87
Hexadecane	12.22

[a]Air Force 1991

3.2 PHYSICAL AND CHEMICAL PROPERTIES

Information regarding the physical and chemical properties of JP-5 and JP-8 is located in Table 3-4.

TABLE 3-4. Physical and Chemical Properties of Jet Fuels[a]

Characteristic	JP-5	JP-8
Molecular weight[b]	No data	No data
Color	Clear and bright[c]	Clear and bright[c]
Physical state	Liquid[d]	Liquid[d]
Melting point	-46°C[c]	-52°C[e] (sample lot)
Boiling point	170°C[f]	170°C[f]
	150–290°C[g]	150–290°C[g]
Density:		
at 15°C	0.788–0.845 kg/L[f]	0.775–0.840 kg/L[f]
Odor	Kerosene-like[e] (kerosene)	Kerosene-like[e] (kerosene)
Odor threshold (ppm)	1[h], 0.082[i] (kerosene)	1[h], 0.082[i] (kerosene)
Solubility		
Water at 20°C	≈5 mg/L[d] (kerosene)	≈5 mg/L[d] (kerosene)
Organic solvent(s)	Miscible with other petroleum solvents[i]	Miscible with other petroleum solvents[i]
Partition coefficients:	3.3–7.06[d] (kerosene)	3.3–7.06[d] (kerosene)
Log K_{ow}	9.6×10^{2} – 5.5×10^{6}[d]	9.6×10^{2} – 5.5×10^{6}[d]
Log K_{oc}	(kerosene)	(kerosene)
Vapor pressure at 21°C	2.12–26.4 mmHg[d] (kerosene)	2.12–26.4 mmHg[d] (kerosene)
Henry's law constant		
At 20°C - atm-m^3/mol	5.9×10^{-5} – 7.4[d] (kerosene)	5.9×10^{-5} – 7.4[d] (kerosene)
Autoignition temperature	229°C[h] (kerosene)	229°C[h] (kerosene)
Flashpoint (minimum)	60°C[c,e]	38°C[c,e]
Flammability limits (% volume in air)	0.7%–5%[h] (kerosene)	0.7%–5%[h] (kerosene)
Conversion factors	No data	No data
Explosive limits	0.7%–5%[j] (kerosene)	0.7%–5%[j] (kerosene)

[a]Values listed are specifications required or general characteristics of each class of jet fuels.
[b]Fuel oils are mixtures of various hydrocarbons designed to meet specifications set forth by the American Society for Testing and Materials (DOD 1992); therefore, molecular weight cannot be determined.
[c]DOD 1992
[d]Air Force 1989b
[e]Air Force 1989a
[f]Army 1988
[g]IARC 1989
[h]Coast Guard 1985
[i]OHM/TADS 1985
[j]HSDB 1998