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swallowing or as a result of spontaneous or induced vomiting following ingestion. Children tend to vomit and aspirate more easily than adults.

The hazard is greater with the lower viscosity fuels, particularly with those which have viscosities of less than 6-7 cSt at 37.8°C (2,8). This includes gas oils. With residual fuel oils, which have much higher viscosities, aspiration is extremely unlikely to occur.

2.1.5 Inhalation

For fuels of relatively high vapour pressure (Table 1) there is the possibility of significant vapour exposure from the more volatile hydrocarbons where the handling system is not closed, particularly in poorly ventilated spaces. Short-term exposure to high concentrations of vapour can lead to symptoms such as irritation of the respiratory system, headaches, nausea and mental confusion. In extreme cases of exposure loss of consciousness can occur; this may be due to the general anaesthetic effect of the vapour or to asphyxiation caused by the vapour displacing air.

It is important to be aware of the danger of asphyxiation from accidental exposure to oxygen-deficient environments. This can arise in fuel storage tanks or, following a large leak or spillage, in nearby low-lying confined spaces, deep pits, etc. This is because fuel vapours are heavier than air and at high concentrations sink to the lowest level of the surroundings, displacing air and causing a deficiency of oxygen for normal breathing. In still air, they dissipate only slowly.

2.2 SPECIFIC CONSTITUENTS

Three fuel constituents, benzene, n-hexane and polycyclic aromatic hydrocarbons (PCAs), have themselves been the subject of much attention and their special hazards need to be considered.

2.2.1 Benzene

Over-exposure to benzene leads to blood and bone marrow abnormalities affecting variably the red and white corpuscles, and the platelets. In some instances it may lead to leukaemia (9,10,11).

The main danger arises from inhalation of benzene vapour. Although small amounts of the liquid can be absorbed through the skin this route of entry is probably not of practical importance. Benzene is a constituent of some gasoline blending components. Among the fuels reviewed in this report it is found in significant concentrations only in gasolines.

Levels of exposure to atmospheric benzene vapour associated with motor gasoline have been reviewed by CONCAWE (12) and have generally been found to be well below the TLV-TWA* level of 10 ppm (13). Precautions may, however, need to be taken in some bulk loading operations or where ventilation is poor in order to make sure that the recommended limit is not exceeded (14).

2.2.2

n-hexane

During recent years n-hexane has been shown to have neurotoxic properties (15). Among the fuels considered in this report, only gasolines contain appreciable concentrations of n-hexane, normally less than 5 vol%. Wide cut aviation kerosine can contain small concentrations also. Nevertheless, under normal conditions airborne concentrations of n-hexane arising from gasoline vapours would be expected to be well below the TLV-TWA level of 50 ppm recommended by the ACGIH (13).

2.2.3

Polycyclic Aromatics

Attention is paid in this report to polycyclic aromatic compounds (PCAs) because some of them have been found in animal tests to be carcinogenic. A general review of the topic is given in Appendix I of the companion report (6), which is based on an extensive critical review of the literature carried out by Bingham *et al* (16). This concluded that the current understanding of the multiple factors affecting carcinogenicity is insufficient for the prediction of carcinogenic potency solely on the basis of physical/chemical analytical methods. Nevertheless the evidence suggests that carcinogenic potency arising from PCAs is negligible for the lighter classes of fuels (LPGs, gasolines and kerosines) since they contain nil or negligible amounts of those PCAs which have been shown to be carcinogenic in experimental animal studies. The main concern arises with some gas oils and fuel oils: in particular those containing certain heavy distillates and residues from crude oil distillation and cracking processes. Under conditions of prolonged and repeated skin contact and poor personal hygiene, there might eventually be a possibility of skin cancer. It is therefore important that adequate precautions are taken to avoid repeated or prolonged exposure to such fuels.

*Threshold limit values (TLVs) recommended by the American Conference of Government Industrial Hygienists (ACGIH) refer to airborne concentrations of substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed, day after day, without adverse effects. The time-weighted average (TWA) values are based on the normal 8-hour workday and a 40-hour workweek.