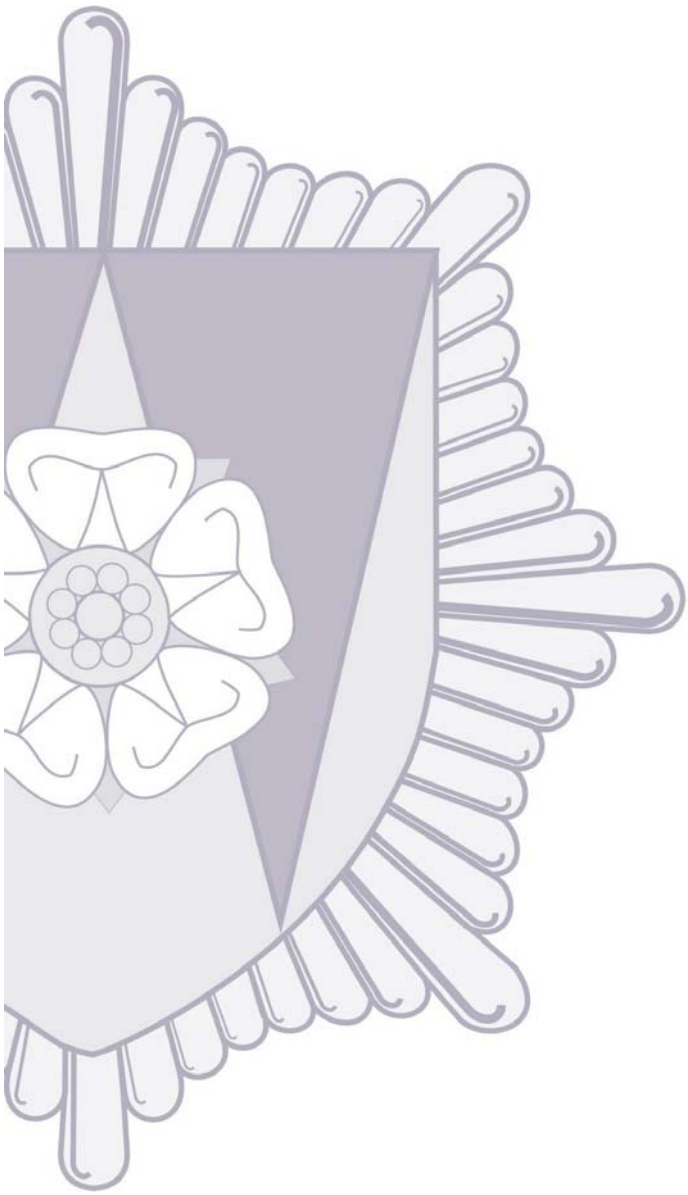
West Yorkshire Fire & Rescue Service

Fire Safety - Information Note FS-INF017

(Previously Supplementary Information Note No 4)

Health Aspects Of Benzene In Petrol



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BENZENE IN PETROL

Over the past 50 years, benzene levels in petroleum derived motor spirit have varied considerably, depending on the refining processes used. In the 1940s, 1950s and 1960s, the benzene content of marketed petrol's has ranged from 0.5 percent to 30 percent by volume but since the 1970s has averaged 23 percent.

For a number of years, both before and after World War II, benzene containing hydrocarbons derived from coal gas production (benzol) were included in some petrol's in brands like National Benzol. Such blends could have consistently high benzene contents, which in the extreme could reach 30 percent by volume.

In the 1960s, the lead content of petrol was by present standards also quite high, being up to 0.84 grammes per litre. Since then, the progressive reduction of lead in petrol has meant that more intensive refining has become necessary to maintain the high-octane quality previously obtained from the lead antiknock additives. Consequently, as lead content was reduced, various refining processes were developed to monitor octane rating, some of which had the effect of increasing slighting the benzene content of petrol.

In 1985 an EEC Directive was introduced which limited the benzene content of motor spirit to a maximum of 5.0 percent volume, Currently the average benzene content of petrol in the United Kingdom is 3 percent volume.

Contrary to some statements on this subject, benzene is not now added to petrol; it is a natural component of crude oil and its concentration may be increased by the additional processing at the refinery necessitated by the reduction or elimination of lead.

HEALTH EFFECTS OF BENZENE

Benzene is rapidly absorbed into the body when swallowed, as might occur if petrol is siphoned by mouth out of a car, for example, or if inhaled as a vapour. Some 50 percent is exhaled unchanged in the breath and the remainder is mainly converted by the liver into phenol and other metabolic compounds, which are excreted in the urine. It is one or more of these products of metabolism, which appear to be responsible for the recognised adverse effects on health described below.

As with other hydrocarbon solvents, extremely high short term exposures may lead rapidly to symptoms of sleepiness, with loss of consciousness and ultimately death if exposure continues.

In practice, of much more concern is the ability of benzene, following repeated or prolonged overexposure, to affect the blood forming tissues in the bone marrow, producing anaemia, reduction of circulating white cells in the blood and very occasionally cancer in the form of leukaemia and perhaps other related conditions such as lymphoma and myeloma. This sequence of events has been observed historically in a few groups of workers where exposures to benzene were uncontrolled, extremely high, and greatly in excess of the occupational exposure level currently permitted. Examples of such groups have included printers and workers involved in the manufacture of rubber coated cloth and shoes using benzene as a solvent. Prolonged and repeated exposure levels well in excess of 100 parts per million (ppm) were apparently not uncommon compared with the current Maximum Exposure Level (MEL) in the United Kingdom of 5ppm.

BENZENE EXPOSURE AND TYPES OF LEUKAEMIA

The development of a variety of leukaemia's has been ascribed to benzene, the most consistent being acute myeloid leukaemia (AML). Cases of AML in the United Kingdom do not appear to be increasing, despite increased facilities for diagnosis and quadrupled sales of motor spirit over the last 40 years. In the United Kingdom there are about 3.9 cases each year per 100,000 of the male population and about 2.8 for females. The condition is somewhat more common in the first five years of life, after which its natural incidence declines until starting to rise again in the fourth decade of life.

There are wide variations in the incidence of leukaemia's between different geographical areas in the United Kingdom, and it is notable that these do not correspond with urban, rural or industrial populations. Significantly, there is a lack of correlation between cluster of leukaemia's on the recently published United Kingdom map of leukaemia's and the location of petroleum refineries.

There is also wide international variation in incidence. The highest European rates are found in parts of Scotland, Denmark, Italy and Switzerland and are in no way linked to the volume of motor spirit used in these countries.

EXPOSURE LEVELS AND TYPES OF EFFECT

It is generally accepted within the scientific community, that established cases of leukaemia in workers associated with benzene exposure have only been found where frequent exposures in excess of approximately100 ppm have occurred over prolonged periods of time, usually years, and adverse effects on the bone marrow have been found only following exposures exceeding around 25 ppm. The latter effects are reversible.

Effects on chromosomes have been claimed at lower levels of exposure but such data as exist are conflicting and the relationship if any, between chromosome damage and leukaemia has not been demonstrated. It is now considered that short term peak exposures may play a greater part in the sequence of events leading to the development of leukaemia than had previously been assumed.

Evidence of excess leukaemia cases among groups of workers exposed to benzene at low levels around or below the current MEL is contentious and subject to rigorous examination by oil industry health scientists. If such a risk exists it must be extremely low. Further epidemiological studies involving much larger groups and having a high statistical power of resolution would be needed to investigate the existence of such low risks. Some researchers have attempted to predict risks at low exposures but invariably these predictions are flawed by use of limited data, inappropriate models and gross underestimates of exposure of the cases. The shape of any dose response curve is entirely unknown, though current evidence suggests it is essentially flat at low level exposures. This implies the existence of a threshold of no effect below which adverse health effects do not occur. Finally, and perhaps most importantly, the way(s) in which excessive exposure to benzene may give rise to leukaemia remain unknown and such explanations as have been advanced are purely speculative.

CONTROL OF EXPOSURE - BENZENE & VOLATILE ORGANIC COMPOUNDS

Volatile Organic Compounds

Because petrol is specifically formulated to evaporate readily in air, petrol vapour and car exhaust gases contain what are termed volatile organic compounds (VOCs).

In the presence of sunlight, VOCs and nitrogen dioxide, also found in exhaust gases, react to form the gas, ozone. Ozone in excess is harmful to all living tissue. Thus a major aspect of EEC air quality legislation is concerned with limiting emissions of VOCs (including benzene) and nitrogen oxides from internal combustion engines and other sources in an effort to limit ozone formation. Since petrol is the source of about 40 percent of total man made VOC emissions, emerging European legislation will require the provision of closed systems for storage, distribution, retail sale and use, so that vapour emission are greatly reduced. As a result, the release of benzene vapour will also be further reduced.

The following measures to contain VOCs are being proposed, or have already been incorporated into legislation:

i Stage I Vapour Recovery - the collection and recovery of petrol vapour normally vented to atmosphere when a road tanker is filled at the distribution terminal and discharged at the retail site. Provisions for marine and rail transport are also included.

ii Stage II Vapour Recovery - the collection of petrol vapour which is displaced from the vehicle's petrol tank when it is being filled at the pump and the return of this vapour to the underground petrol storage tank, where it replaces the petrol pumped into the vehicle.

iii Catalyst cars - from 1993 all new petrol engine cars will be fitted with catalytic converters which will reduce by 80/90 per cent the quantity of VOCs emitted from vehicle exhausts by converting them to carbon dioxide and water. The legislation, the Consolidated Emissions Directive, also introduces the requirement for the fitting of small carbon canisters on cars to trap and later use the vapour given off by a hot engine when the vehicle is stationary or when subject to diurnal changes in temperature. Future legislation may increase the capacity of carbon canisters to make the capture of petrol vapour an even more efficient process.

Petrol Volatility Reductions

If petrol volatility is lowered, in addition to beneficially affecting VOC emissions, benzene evaporation will also be reduced, as less of it will be coevaporated with the smaller, more volatile molecules. Last year the British Standards for petrol were changed to reduce petrol volatility in the winter, spring and autumn periods.

In January 1993 the volatility will be further reduced for all seasons of the year when the new CEN standards are introduced for petrol in Europe.

Reduction in Pollutants

These far reaching measures will reduce dramatically the level of air pollution from petrol derived volatile hydrocarbons and hence the extent of ground level ozone creation, particularly in areas of high traffic density. Concurrently, benzene emissions will be reduced as a result of these technological improvements to both vehicles and petrol distribution systems.

CONCLUSIONS

a) Benzene is a natural component of both crude oil and petrol. Contrary to press statements, benzene is not added to petrol.

b) By law its concentration in petrol is limited to a maximum of 5 percent by volume. In practice the average benzene content of petrol in the United Kingdom is about 3 percent volume.

c) Benzene is a know carcinogen which, at repeated, excessive and prolonged exposure levels, may cause leukaemia, particularly AML.

d) Despite the four-fold increase in the use of petrol over the last 40 years, the incidence of AML is not increasing. The incident of AML does not correspond with urban, rural or industrial area, or with the locations of petroleum refineries.

e) A casual link between low (non occupational) levels of exposure of benzene and the incidence of leukaemia has not been established.

f) Measures to limit the emissions of volatile organic compounds from both vehicles and petrol distribution systems will also reduce by up to 90 percent any incidental exposure of the general public to petroleum derived benzene.

CHEMICAL DATA

1. Benzene (C 6 H 6) is a pure aromatic hydrocarbon of a characteristic odour. It occurs naturally but is usually obtained from byproducts of the carbonisation of coal. As a clear colourless liquid, which is not soluble in water, it burns with a smoky flame. Vapours from an explosive mixture with air,

FP = -11NC

Also known as Benzol, Phenyl Hydride or Coal Naphtha.

2. Ozone O3 occurs in small concentrations in the atmosphere. It is produced by the action of ultraviolet radiation on air or oxygen and by electric sparks in air or oxygen. It is a powerful oxidizing agent.

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