

HSE's DISEASE REDUCTION PROGRAMME - CANCER PROJECT**Profiling of Occupational Carcinogens****Identity****Rubber Process Dust and Rubber Fume**

Rubber manufacturing and processing giving rise to rubber process dust and fume may lead to workers being exposed to many chemical substances. The available literature indicates that the following potentially carcinogenic substances may have been present in the rubber industry including; cadmium and cadmium compounds, chromium VI compounds, diesel engine exhaust, environmental tobacco smoke, nitrosamines such as n-nitrosodiethylamine and n-nitrosodimethylamine, nickel compounds, aromatic amines and polycyclic aromatic hydrocarbons.

Rubber fume

Defined in HSE's Summary Criteria for Occupational Exposure Limits (1994) as 'fume evolved in the mixing, milling and blending of natural rubber or synthetic elastomers, or of natural rubber and synthetic polymers combined with chemicals, and in the processes which convert the resultant blend into finished products or parts thereof, and including and inspection procedures where fume continues to be evolved. Rubber fume occurs where rubber or synthetic polymers become heated and may be present in areas where extrusion and vulcanisation are carried out'. Rubber fume is a complex and indeterminate mixture of substances and therefore specific details of substances present in rubber fume are not given in the available carcinogenicity assessments for this material. Rubber fume can be measured as cyclohexane soluble material.

Rubber process dust

Defined in HSE's Summary Criteria for Occupational Exposure Limits (1994) as 'dust arising in the stages of rubber manufacture where ingredients are handled, weighed, added to or mixed with uncured material or synthetic elastomers'. Rubber process dust is a complex variable mixture of particulates and therefore specific details of substances present in rubber process dust are not given in the available carcinogenicity assessments for this material. Carbon black is used as a "filler" in rubber, and so rubber dust may contain a high % of carbon black.

Name: AJS

Date. 19/5/06

Regulatory history

2006. IARC plans to review the carcinogenicity of rubber fume; the work is expected to be completed within 2-3 years.
2005. UK occupational exposure limits (OELs): as part of a number of changes to the OEL framework, the existing maximum exposure limit for rubber process dust of 6 mg.m^{-3} (8-hour TWA) was translated to a workplace exposure limit of 6 mg.m^{-3} (8-hour TWA). This limit is subject to review pending the outcomes of the HSE's Disease Reduction Programme Cancer Project prioritisation activity. For rubber fume, the existing maximum exposure limit of 0.6 mg.m^{-3} (8-hr TWA) was translated into a workplace exposure limit of 0.6 mg.m^{-3} (8-hr TWA). A 'Carc' notation was added to both the rubber fume and rubber process dust WELs in line with the provisions of this new framework.
2003. HSE published 'Tread Safely. A guide to health and safety in the tyre retread industry. Section 13 deals with Rubber fume'.
2001. The Rubber Industry Advisory Committee (RUBIAC) published a statement, prepared jointly with HSE, to clarify the position on occupational cancers within the industry (see Annex 1).
1997. RUBIAC published 'Health and Safety in the Rubber Industry' which included a practical guide to complying with COSHH, advice on the control of solvents in the rubber industry and dust control in powder handling and weighing, and guidance on training. RUBIAC advises the HSC and includes representatives from employer and employee organisations, as well as professional and technical experts.
1995. HSE published the following leaflet: Safe to Breathe; Dust and Fume Control in the Rubber Industry
1994. The OEL for rubber process dust was reduced from 8 mg.m^{-3} (8-hour TWA) to 6 mg.m^{-3} (8-hour TWA) (a maximum exposure limit), accounting for achievability in the industry.
- Rubber fume and rubber process dust were defined as carcinogens and included in Schedule 1 of the COSHH regulations.
1992. RUBIAC published 'COSHH in the Rubber Industry' showing how the requirements of COSHH may be complied with.
1990. The OEL for rubber fume reduced from 0.75 mg.m^{-3} (8-hour TWA) to 0.6 mg.m^{-3} (8-hour TWA) (a maximum exposure limit).
1990. The British Rubber Manufacturer's Association (BRMA) published a 'Code of Practice' providing a detailed review of rubber chemicals in use together with information on the hazardous properties likely to be of concern to the user. This was widely accepted as the standard source for work involving rubber chemicals.
1987. OEL for rubber fume set at 0.75 mg.m^{-3} (8-hour TWA) (a maximum exposure limit).
OEL for rubber dust set at 8 mg.m^{-3} (8-hour TWA) (a maximum exposure limit)
1987. IARC concludes that 'working in the rubber industry entails exposures that are carcinogenic to humans' and classifies the rubber industry in Group 1.

Name KF/AJS

Date updated 15/2/06

Summary

In a review published by IARC (1982), evidence was presented to link occupational exposures to dust and/or fume in the UK rubber industry with increased risks of bladder, stomach and lung cancer. Data from the US also suggested similar links with prostate cancer and leukaemia.

In a more recent review, Kogevinas et al (1998) noted that excess risks of bladder cancer, lung cancer and leukaemia have been found consistently in studies of cancer risk in the rubber industry. They also noted the evidence for an increased risk of stomach cancer among UK rubber industry workers, but that this was not replicated in studies from other countries. There was some evidence for a small increased risk of laryngeal cancer in some studies. They acknowledged that confounders had generally been inadequately controlled in the available studies and that preventive measures and other changes to the rubber industry in recent years could have reduced cancer risks,

Taking into account the evidence presented in both of these reviews, it seems unlikely that a potent carcinogenic hazard is presented today by rubber process dust and rubber fume in UK industry.

Human evidence

There are a number of difficulties in relating particular exposures to disease. For instance an individual worker may be exposed to a number of substances due to the variety and change of chemicals used in a given job, there may be cross-contamination between jobs and workers in this industry will often move between jobs within the production process.

Bladder cancer

An increased incidence of bladder cancer reported in UK rubber workers who were employed before 1950 has been attributed to the use of anti-oxidants containing the human bladder carcinogen 2-naphthylamine during processing. In the UK, following the withdrawal of these anti-oxidants in 1949 no excess of bladder cancers has been observed. In the most recent study (Veys, 2004), a cohort of UK rubber industry workers was followed from 1969 until 1995 for their bladder cancer morbidity and mortality experiences. A total of 5128 men (from a single factory) employed either between 1945 and 1949, and therefore exposed to 2-naphthylamine, or only after 1950 were included. A statistically significant increased risk of bladder cancer was seen in the workforce exposed to 2-naphthylamine (national standardised registration rates (SRR_N) = 171: 95% CI 130-221), whereas no excess was seen in the workforce employed after 1950 (SRR_N = 102 with 95% CI = 72-139). No consistent excess of bladder cancer has been found in comparable studies of US rubber workers. On the basis of this evidence, it appears that there is currently either a low or no risk of occupational bladder cancer in the UK rubber industry.

Stomach cancer

Slightly increased risks of stomach cancer have been identified in studies of US and UK rubber industry workers (IARC, 1982). The risks were observed for a number of jobs throughout the production process, but no consistent pattern was seen across all studies. In a cohort study of UK rubber industry workers (36 696 men from 13 different factories) exposed for at least 1 year between 1946 and 1960, an SMR of 122 (173 observed cases/141.8 expected cases) was reported for stomach cancer. The increased risk was related to rubber compounding, extruding, component building and maintenance work. No further details about the nature or duration of the exposures of these workers to rubber dust and/or fume are available. A census study (40 867 men) of British workers employed in rubber and cabling industries for at least 1 year on 1st February 1967 also indicated an excess of stomach cancer. The observed/expected ratio of cases was reported as 216/176.4 and the excess was associated with jobs later in the production line. In three studies from US rubber and tyre manufacturing plants where workers were exposed for at least 5 years, the observed/expected death rates for stomach cancer were reported as 13/5.9, 15/7.1 and 39/20.9 respectively. In these studies stomach cancer was associated with compounding, mixing, milling and testing jobs. Overall, IARC were unable to rule out confounding as an explanation for these cancer findings and Kegevinas et al (1998) commented that the small risks observed were well within the margins of an effect of confounding by socioeconomic status. However, even if the data do reflect the result of exposure to carcinogenic rubber dust and/or fume for workers employed in the 1960s and earlier, there is insufficient evidence to enable an assessment of potency.

Recently, Straughan and Sorahan (2000) reported the preliminary findings of a study being sponsored in the UK by the British Rubber Manufacturers' Association (BRMA). The study includes a cohort of

9031 male and female workers from a total of 42 rubber factories who were first employed in the factory environment between 1982 and 1991. Using data on mortality for the period 1983 to 1998 and on cancer registration from 1983 to 1994, no evidence for an increased risk of stomach cancer within the cohort has been found. A further analysis of the cohort is to be reported in 2006 – this will extend the follow-up period to 2003. Although it is too early to conclude whether or not workers in the cohort are at an increased risk of stomach cancer (the mean follow-up period being only 11.9 years), the preliminary evidence at least suggests that they have not been exposed to an exceptionally potent carcinogen.

Lung cancer

Studies of UK rubber industry workers have described an increased risk of lung cancer for workers in both the tyre-making and general rubber goods sectors (IARC, 1982). In the cohort study of 36,696 UK workers (see above), the SMR for lung cancer was 122 with observed/expected death rates of 633/517.4. This excess was associated with component builders, curing, inspection, handling of finished goods and maintenance jobs within the tyre and non-tyre sectors and also with compounding and extruding jobs in the non-tyre sector. In the study that took data from the 1967 census, the observed/expected death rates for lung cancer were 326/299.4 for the tyre workers and 496/465.0 for general rubber goods workers. The largest risk was reported for workers employed to mix latex (18/10.8). Similar findings have been found in US rubber plant workers (IARC, 1982). The basis for these increased risks of lung cancer have not been fully explained. It is plausible that they were a result of exposure to lung carcinogens in rubber dust or fume but equally they could be explained by confounding or socioeconomic factors. There are insufficient data available to clarify this. In their preliminary study, Straughan and Sorahan (2000) found no evidence for an increased risk of lung cancer among relatively recent entrants to the UK rubber industry. As for stomach cancer, this at least suggests that the workers have not been exposed to an exceptionally potent carcinogen.

Other cancers

Increased risks of lymphatic and haematopoietic cancers, particularly lymphatic leukaemia, found in US rubber workers have been linked to jobs that led to exposure to solvents. Benzene, known to cause leukaemia, was once used as a solvent in the rubber industry and may still be present as a contaminant of other solvents (IARC, 1987). If benzene were to be present in solvents used in the UK rubber industry, then there might especially be reason for concern about the risk of increased haematopoietic cancers among exposed workers.

There has been some suggestion of an excess of prostate cancer associated with compounding and mixing jobs in studies of workers from the US employed in rubber and tyre factories between 1940 and 1978. A possible occupational risk factor may be cadmium, compounds of which are occasionally included in rubber batches (IARC, 1982). However, in 2004, the UK Committee on Carcinogenicity (CoC) considered all the available evidence and concluded that there was no convincing case for such an association.

Other cancers have been reported including those of the renal tract, pancreas, oesophagus, liver, skin, colon, larynx and brain, however no consistent excess of any of these cancers is seen across the various studies (IARC, 1987).

Straughan and Sorahan (2000) found 3 deaths from testicular cancer, set against 0.51 expected for their cohort (SMR 589: 95% CI 122-1722). However, corresponding incident findings were not exceptional, suggesting that working in the rubber industry was not a risk factor. An update of this study is expected in 2006.

A recent meta-analysis involving twenty cohort studies of rubber and tyre industry workers (Borak *et al.*, 2005) gave an overall relative risk for brain cancer of 0.90 (95% CI = 0.79-1.02). This provides a persuasive argument that there is no increased risk of this cancer resulting from occupational exposures in the rubber and tyre industries.

Mechanism

Rubber fume and rubber dust both contain small and variable amounts of potentially mutagenic substances, including polycyclic aromatic hydrocarbons and various metals and their salts. Mechanisms by which rubber fume or dust may cause cancer have not been established, but it the possibility of a genotoxic mode of action cannot be discounted.

Name KF/AJS

Date 12/04/05 (updated 16/2/06)

Additional hazards listed in the UK Classification & Labelling Approved Supply List

Not applicable

Provisional Potency Estimate: B

No evidence of especially high potency; causal relationship not always clear.

Toxicology References

Borak, J. *et al.*, (2005) Risks of brain tumours in rubber workers: a meta-analysis. *J. Occup. Environ. Med.* 47(3): 294-298.

HSE EH64/C24 (1994). Rubber Fume In: *Summary Criteria for Occupational Exposure Limits*. HSE Books

HSE EH64/C41 (1994). Rubber Process Dust In: *Summary Criteria for Occupational Exposure Limits*. HSE Books

IARC (1982). The rubber Industry. In: *IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans*. Vol 28

IARC (1987). Overall Evaluations of Carcinogenicity: an Update of IARC Monographs Volumes 1 to 42. Supplement 7.

Kogevinas M, Sala M, Boffetta P, Kazerouni N, Kromhout H and Hoar-Zahn S (1998). Cancer risk in the rubber industry: a review of the recent epidemiological evidence. *Occup Environ Med*, 55, 1-12.

Straughan JK and Sorahan T (2000). Cohort mortality and cancer incidence of recent entrants (1982-91) to the UK rubber industry: preliminary findings. *Occup Environ Med.* 57, 574-576].

Veys C. A. (2004). Bladder tumours in rubber workers: a factory study 1946-1995. *Occ. Med.* 54: 322-329.

Occurrence

1. Rubber fume is a complex process-generated material and can occur where rubber or synthetic polymers are heated.
2. Rubber fume is not listed in the CHIP Approved Supply List

Use

1. Exposure to rubber fume can occur during tyre manufacture and retreading, slipper manufacture and in the manufacture of moulded rubber goods (gaskets, seals, fan belts etc).
2. The UK rubber industry is well established, has strong links with HSE and is likely to employ significant numbers of workers for the foreseeable future.

Human exposure

1. Route of exposure is via inhalation.
2. A 1984 survey showed 19% of results in calendaring and extrusion above 0.5 mg/m³.
3. The 1984 survey also showed 53% of samples from vulcanising were above 0.5 mg/m³, and 16% above 2 mg/m³.
4. A simple analysis of HSE data (NEDB) shows mean exposure to rubber fume over the period 1980-1997 was 0.94 mg/m³ (66 sites).
5. A further analysis shows that since the introduction of a MEL of 0.6 mg/m³ for rubber fume in 1989, mean exposure was 0.88 mg/m³ (40 sites from period 1989-1997).
6. The 1995 A Dost survey identified that 19% of the sampling results exceeded the MEL.
7. An estimated <10,000 persons may be exposed to rubber fume at <250 UK sites. (Phone conversation with sector)

Occupational hygiene priority classification

In view of the large amount of rubber handled, coupled with the high number of workers potentially exposed, rubber should remain a high priority substance for further work in relation to the chemical carcinogens project.

Additional information

1. See also the profile on butadiene - workers in the synthetic rubber industry may be exposed to this carcinogen (associated with increased risk of leukaemia).

RUBIAC STATEMENT ON OCCUPATIONAL CANCERS

Published in the Newsletter of the Rubber Industry Advisory Committee
August 2001

1 This statement has been prepared by the Health and Safety Executive (HSE) along with employer and employee representatives from the Rubber Industry Advisory Committee (RUBIAC).

2 It is known that workers in the UK rubber industry have suffered from a higher incidence of bladder cancer than the male population in general. The cause of these tumours was identified in 1949 as *Beta naphthylamine*, present as a contaminant in one of the chemicals used in rubber compounding called *Nonox S*. As soon as the discovery was made all use of *Nonox S* and similar contaminated antioxidants was immediately stopped.

3 Epidemiological studies carried out by the HSE and Birmingham University (in association with the BRMA) eventually demonstrated that the increased number of bladder tumours disappeared after the removal of the contaminated chemicals in 1949.

4 Unfortunately, however, these studies also reported that there were slightly more stomach and lung cancers occurring in rubber workers who were employed in the industry between 1945 and 1976 than would normally be expected in the general UK population. The stomach cancers appeared to be related to rubber dust exposure and the lung cancers to vulcanising fume exposure.

5 In 1986 legally binding Maximum Exposure Limits (MELs) for rubber process dust and fume were introduced in the UK. Current limits are 6 mg/m³ (for dust) and 0.6 mg/m³ (for fume). Rubber companies generally monitor the air in their factories annually. A recent survey by HSE showed that while personal exposure levels were typically well within these limits, assessment of risk, control of fume, standards of cleanliness and ventilation needed to be given high priority to maintain acceptable standards.

6 In order to test the effectiveness of these limits and the impact of other improvements in working conditions the BRMA asked Professor Sorahan of Birmingham University to carry out a new study of all individuals first employed in the industry between 1982 and 1991.

7 Analysis of the early results of this study shows no evidence of increased risk for stomach or lung cancer. Many cancers take years to develop, but this news is nevertheless encouraging and a strong indication that improved working conditions have been effective in reducing ill health. The agents causing cancer have not been eliminated (as was the case with *Nonox S*) so it is important that such positive findings do not lead to any reduction in the use and maintenance of preventive measures in individual workplaces.

8 The HSE, the Trade Unions and the industry associations will be closely monitoring future results. Keeping well within these legal limits is the number one health priority for the industry. More detailed publications for those with managerial or technical responsibilities are available from HSE and the BRMA.

Contact: HSE 0114 283 4200
BRMA 0207 7457 5040