

The burden of occupational cancer in Great Britain

Overview report

Prepared by the **Health and Safety Laboratory**,
the **Institute of Environment and Health**,
the **Institute of Occupational Medicine** and
Imperial College London
for the Health and Safety Executive 2012

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Overview report

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This project aimed to estimate of the current burden of cancer for Great Britain due to occupational exposure to carcinogenic agents/ exposure circumstances. The measure of the burden of cancer used was the attributable fraction (AF) i.e. the proportion of cases that would not have occurred in the absence of exposure. Data were obtained on the risk of the cancer for each exposure, accounting for confounding factors, and the proportion of the population exposed over the relevant exposure period. Carcinogenic agents/exposure circumstances, classified by the International Agency for Research on Cancer as definite (Group 1) or probable (Group 2A) human carcinogens were considered. Overall estimates are presented for cancer registration (incidence) data in 2004, and mortality data in 2005.

The estimated total (male and female) AF and deaths related to overall occupational exposure is 5.3%, giving 8010 attributable deaths (men: 8.2% (6355); women 2.3% (1655)). The estimated total (male and female) AF and registrations related to overall occupational exposure is 4.0%, giving 13598 attributable registrations (men: 5.7% (9988); women 2.1% (1655)).

Occupational AFs are over 2% for the following cancers: bladder, breast, larynx, lung, mesothelioma, nasopharynx, non-melanoma skin cancer, oesophagus, sinonasal, and soft tissue sarcoma. Asbestos, shift work, mineral oils, solar radiation, silica, diesel engine exhaust, polycyclic aromatic hydrocarbons from coal tars and pitches, occupation as a painter or welder, dioxins, environmental tobacco smoke (non-smokers), workplace exposure to radon, tetrachloroethylene, arsenic and strong inorganic mists each contribute 100+ registrations.

This report and the work it describes were funded by the Health and Safety Executive (HSE). Its contents, including any opinions and/or conclusions expressed, are those of the authors alone and do not necessarily reflect HSE policy.

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First published 2012

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ACKNOWLEDGEMENTS

Funding was obtained from the Health and Safety Executive (HSE). Andrew Darnton from the HSE was responsible for the work on mesothelioma. The contributions to the project and advice received from many other HSE and Health and Safety Laboratory staff is gratefully acknowledged. Two workshops were held during the project bringing together experts from the UK and around the world. We would like to thank all those who participated and have continued to give advice and comment on the project. We would also like to thank Helen Pedersen and Gareth Evans for their help in editing and formatting the reports.

EXECUTIVE SUMMARY

INTRODUCTION

HSE wishes to develop appropriate practical measures to reduce the incidence of occupational cancer in Great Britain; they currently rely on estimates of the effects of occupation on cancer mortality in the US made by Doll & Peto in 1981 (4% of all US cancer deaths with an uncertainty range of 2% to 8%). The overall aims of this project were:

- to produce an updated estimate of the current burden of occupational cancer specifically for Great Britain
- to produce an estimate of the future occupational cancer burden in Great Britain based on recent and current exposures, together with the method for updating this in future
- where the data are sufficiently detailed, to break down any headline estimates into exposure-cancer combinations

This report presents an overview of the results of the current burden of cancer due to occupational carcinogens and circumstances in Great Britain (GB) together with a summary of the methodology developed and the data used.

METHODOLOGY

The primary measure of the burden of cancer used in this project was the attributable fraction (AF) i.e. the proportion of cases that would not have occurred in the absence of exposure; this was then used to estimate the attributable numbers. The AF requires the risk of the disease due to the exposure of interest and the proportion of the target population exposed. Estimation was carried out for 2005 for mortality and 2004 for cancer incidence for occupational exposures and for agents classified by the International Agency for Research on Cancer (IARC) as group 1 (established) and 2A carcinogens (probable).

Risk estimates, adjusted where appropriate for confounders, were obtained from key studies, meta-analyses or pooled studies, taking into account study quality. Dose-response risk estimates were generally not available in the epidemiological literature nor were proportions of those exposed at different levels of exposure over time available for the working population in GB. However, where possible risk estimates were obtained for an overall 'lower' level and an overall 'higher' level of exposure to the agents of concern and matched appropriately to the exposure scenario in question. The risk estimates for occupational exposure to ionising radiation were derived using generalized linear dose response models of excess relative risk per unit of cumulative radiation dose from the United Nations Scientific Committee on the Effects of Atomic Radiation.

The period during which exposure occurred that was relevant to the development of the cancer in the target year 2005 was defined as the risk exposure period (REP). For solid tumours a latency of 10-50 years was assumed giving a REP of 1956-1995; for haematopoietic neoplasms 0-20 year's latency was assumed giving a REP of 1986-2005. The proportion of the population ever exposed to each carcinogenic agent or occupation in the REP was obtained from the ratio of the numbers ever exposed to the carcinogens of interest in each relevant industry/occupation within GB over the total number of people ever employed. National data were used to obtain these. Account was taken of changes in numbers employed in the primary and manufacturing industry and service

sectors in GB over the REP and adjustment was made where appropriate for employment turnover over the period.

RESULTS

The overall burden in GB attributable to the occupational carcinogens was 5.3% (based on deaths (8.2% for men and 2.3% in women). Numbers of attributable deaths are 8010 overall (6355 for men, 1655 for women) and numbers of attributable cancer registrations are 13598 overall (9988 for men, 3611 for women). The AFs by cancer site range from less than 0.01% to 95% overall, the most important cancer sites for occupational attribution being, for men, mesothelioma (97%), sinonasal (43.3%), lung (21.1%), nasopharynx (10.8%), bladder (7.1%) and NMSC (6.9%), and for women mesothelioma (82.5%) sinonasal (19.8%), lung (5.3%), breast (4.6%) and nasopharynx (2.4%). Occupation also contributes 2% or more overall to cancers of the larynx, oesophagus and soft tissue sarcoma (STS), with in addition for men melanoma of the eye (due to welding), non-Hodgkin's lymphoma (NHL), and stomach. Lung cancer contributes the largest number of attributable deaths for both men and women followed, for men, by mesothelioma, bladder, oesophageal and stomach cancers, and for women, by breast cancer, mesothelioma, bladder and oesophageal cancers. For attributable numbers of cancer registrations, the patterns differ between men and women; for men, lung cancer contributes the largest numbers of registrations followed by NMSC, mesothelioma, bladder, oesophageal and stomach cancers, non-Hodgkin's lymphomas and sinonasal cancer; for women breast cancer contributes the largest numbers of registrations followed by lung cancer, NMSC, mesothelioma, bladder cancer, non-Hodgkin's lymphoma, ovarian, sinonasal and oesophageal cancers.

Many carcinogenic exposures in the workplace affect multiple cancer sites. Asbestos contributes the most to both total attributable deaths and registrations (larynx, lung, mesothelioma, stomach). Others making a major contribution to attributable deaths and/or registrations include arsenic (lung), diesel engine exhaust (DEE) (bladder, lung), dioxins (lung), environmental tobacco smoke (ETS) encountered at work in non-smokers (lung), mineral oils (bladder, lung, non-melanoma skin cancer (NMSC), sinonasal), polycyclic aromatic hydrocarbons from coal tar and pitches (NMSC), radon from natural exposure in workplaces (lung), shift work, including flight personnel (breast), silica (lung), solar radiation (NMSC), strong inorganic acid mists (larynx, lung), tetrachloroethylene (cervix, non-Hodgkin's lymphoma, oesophagus), work as a painter (bladder, lung, stomach) and work as a welder (lung, melanoma of the eye due to ultra violet radiation).

Industry sectors contributing substantially to the total burden includes construction, land transport, manufacture of transport equipment, metal workers, mining, painters and decorators in the construction industry, personal and household services (this sector includes repair trades, laundries and dry cleaning, domestic services, hairdressing and beauty), printing and publishing, public administration and defence, roofers and road repairs, shift work, and wholesale and retail trades. The majority of industry sectors involve exposure to several carcinogens (many over 10) with construction and many of the manufacturing sectors involving potential exposure to between 15 and 20 carcinogens. There are several key exposures which give rise to substantial numbers of registrations across multiple industry sectors. Of note is the contribution of exposure to (i) asbestos, DEE, silica and solar radiation in the construction industry; (ii) asbestos, DEE, ETS (non-smokers), soots and tetrachloroethylene in personal and household services; (iii) asbestos and DEE in land transport (railway, road, pipelines); (iv) asbestos, DEE, silica and solar radiation in mining; (v) ETS (non-smokers) and solar radiation in public administration and defence; (vi) asbestos, ETS (non-smokers) and radon in the wholesale and retail trade, restaurants and hotels and (vii) dioxins, non-arsenical insecticides and solar radiation in farming.

DISCUSSION

This project is the first to quantify in detail the burden of cancer due to occupation specifically for GB. The project highlights the impact of occupational exposures, together with the occupational circumstances and industrial areas where exposures to these agents occurred in the past, on population cancer morbidity and mortality. Our methodological approach was developed with advice, discussion and peer review from international experts, including IARC, throughout the project and at two international workshops. It takes account of issues such as latency and the period in which relevant exposure would occur, changes in workforce turnover and employment trends and the potential to be exposed to several carcinogens concurrently and at different levels. These methods have the potential to be adapted for use in other countries and extended to include social and economic impact evaluation.

However, assumptions made in our methodology and uncertainties and inaccuracies in the data may have introduced biases into our estimates. Inclusion of IARC group 2A carcinogens may have inflated our estimates; alternatively exclusion of IARC group 2B (possible) carcinogens and other suspected or unknown carcinogens may have led to an underestimation. Other caveats include inappropriate choice of risk estimates, imprecision in the risk estimates and estimates of proportions exposed, inaccurate assumptions about the risk exposure and latency periods, and in some cases a lack of separate risk (and/or cancer incidence) estimates for women.

Due to the long latent interval of many cancers the estimates of current burden are based on exposures occurring in the past. Many of these would have been considerably higher than today and there is evidence of continuing downward trends in the UK in many exposures. However, it should be noted that for many of the carcinogens a major contribution to the burden was made by a large number of workers exposed at low levels and low risk.

Separate reports present the results for the current burden for each individual cancer site; estimates of Disability-Adjusted Life Years; methods to predict future estimates of the occupational cancers; application of the future burden methods to predict future burden for important hazards; and the results of sensitivity analysis of these estimates to sources of uncertainty and bias.

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1.0 INTRODUCTION

In 1981 in their report to the US Congress, Doll & Peto presented a method of estimating the effects of occupation on cancer mortality in the US (Doll & Peto, 1981). The proportion of cancer they attributed to occupation was about 4% of all US cancer deaths with an uncertainty range of 2% to 8%. More recently they have produced a new estimate of 2% with a range of 1-5% and suggest that less than 1% is known to be avoidable by practicable ways (Doll and Peto, 2005). The Health and Safety Executive (HSE) has relied on the 1981 study to estimate the proportions of cancers in Great Britain (GB) due to occupational exposures, giving an estimate of around 6000 cancer deaths (uncertainty range 3000 to 12000) and 12000 cancer registrations (uncertainty range 6000 to 24000) currently occurring each year in GB. In a later overview of the epidemiology of cancer, Doll & Peto suggested that it is unlikely that occupational hazards account for more than two or three per cent of all fatal cancers in developed countries such as the UK, but they acknowledge that the quantitative evidence is uncertain and the estimate could be out by a factor of two (Doll & Peto, 2003).

HSE wishes to develop appropriate practical measures to reduce the incidence of occupational cancer in Great Britain. These measures could include improved risk assessment, chemical substitution, improved control measures and evidence of their effectiveness. It will be important that these can be employed in small- and medium-sized enterprises as well as larger businesses. Future strategies for deciding where HSE targets its action on workplace carcinogens through policy-making, advice and enforcement activity are dependent on a sound evidence base. This evidence base will also help determine HSE's priorities for preventing future disease.

It is acknowledged that the estimates of current burden of cancer due to occupational exposures are based on evidence and methodology that is over 25 years old, and that it is now appropriate that the validity of these estimates is reassessed using currently available scientific evidence.

The aims of this project carried out by Imperial College London in collaboration with the Health and Safety Laboratory (HSL), the Institute of Environment and Health (IEH) at Cranfield University and the Institute of Occupational Medicine (IOM) were:

- to produce an updated estimate of the current burden of occupational cancer in Great Britain
- to produce an estimate of the future occupational cancer burden in Great Britain based on recent and current exposures, together with the method for updating this in future
- to the extent that the data will allow, to break any headline estimates down into exposure-cancer combinations

These estimates will inform the HSE's ongoing deliberations, as part of the cancer project of the Long Latency Disease Programme, on the priorities for intervention on occupational carcinogens.

This report presents an overview of the results of the current burden of cancer due to occupational carcinogens and circumstances in GB together with a summary of the methodology developed and the data used. Separate technical reports for each cancer giving more details of the source data, cancer burden calculations, and statistical methodology will be made available on the HSE website during 2010. Other reports will include methods for predicting the future burden of occupational cancers due to recent exposures, and the application of these methods to priority carcinogens and exposure circumstances. Other measures of burden will be reported such as Years of Life Lost and Disability-Adjusted Life Years, as well as a report summarizing the application of a sensitivity analyses to determine the biases and uncertainties surrounding these estimates of cancer burden.

2.0 METHODOLOGY

1.1 OVERVIEW OF THE STUDY DESIGN

For each cancer, information on the incidence, mortality and survival trends in GB was obtained and an overview of the aetiology and known and suspected causal factors, including occupationally related factors, was carried out. Estimation was carried out using 2005 data for mortality and 2004 for cancer incidence. Mortality data were obtained from the Office for National Statistics (ONS), and the General Register Office for Scotland. Cancer incidence data were obtained from ONS, Cancer Statistics, Registrations, Series MB1 for England, the Scottish Cancer Registry, and the Welsh Cancer Intelligence and Surveillance Unit.

The attributable fraction (AF) i.e. the proportion of cases that would not have occurred in the absence of an occupational exposure was estimated; this was then used to estimate the attributable numbers. There are several methods for estimating the AF but all depend on knowledge of the risk of the disease due to the exposure of interest and the proportion of the target population exposed (Steenland *et al*, 2006).

2.2 RISK ESTIMATES

Risk estimates were obtained from key studies, meta-analyses or pooled studies, taking into account quality (including relevance to GB, sample size, extent of control for confounders, adequacy of exposure assessment, and clarity of case definition). Studies could be industry-based cohort studies or population-based case-control studies.

Factors that were considered for the choice of study included:

- Representativeness
 - Broad based and representative of the occupations or industrial exposures in GB
 - Included separate evaluations for men and women if relevant
- Study quality
 - Large sample size
 - Control for confounders i.e. adjusted analyses carried out
 - Adequate exposure assessment in the study
 - Standardised diagnosis of cancer cases
 - Appropriate comparison or a control population
- Portability, for which there are three key issues:
 - UK study or similar population, so that the source study and target (GB) exposures match on types and levels of exposure
 - Up-to-date study, so that the relevant period of exposure in the source population is not so long ago that the exposures on which the risk estimates were based no longer match exposures in the target relevant exposure period
 - Comparable distribution of known confounders within GB population.

Where possible, risk estimates were selected that were adjusted for important confounders or non-occupational risk factors e.g. smoking for lung cancer, smoking and alcohol use for laryngeal cancer. Where only a narrative review was available giving a range of risk estimates from several relevant studies a combined estimate of the relative risks (RR) was calculated based on a random- (for heterogeneous RRs) or fixed- (for homogeneous RRs) effects model. Formal systematic

reviews and meta-analyses were carried out to estimate risk estimates for laryngeal and stomach cancers related to asbestos exposure.

Dose-response risk estimates were generally not available in the epidemiological literature nor were proportions of those exposed at different levels of exposure over time available for the working population in GB. However, where possible risk estimates were obtained for an overall 'lower' level and an overall 'higher' level of exposure to the agents of concern and matched appropriately to the exposure scenario in question.

The risk estimates for occupational exposure to ionising radiation were derived using generalized linear dose response models of excess relative risk per unit of cumulative radiation dose from the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR, 2006). Cumulative lifetime dose was estimated using data from the Central Index of Dose Information (CIDI) (HSE, 1998). For aircrew, who are not covered by CIDI, the mean total lifetime radiation dose per pilot was obtained from a large cohort study of European airline pilots (Langner *et al*, 2004) and combined with numbers employed obtained from the British Airways Stewards and Stewardesses Union (BASSA, 2008) and the Labour Force Survey.

A substantial proportion of the excess is likely to occur in the large number of workers with low exposures for whom estimates of average risks are inevitably unreliable. Where no risk estimate could be identified for very low/background levels of exposure for a particular carcinogen, a RR was estimated for the 'lower exposed' group by (i) taking the harmonic mean of all the available ratios of 'higher' to 'lower' RR estimates for cancer-exposure pairs for which data were available, (ii) applying this average ratio to the 'higher' level estimate for the carcinogen to obtain a 'lower' level RR estimate for the carcinogen. If the resulting RR estimate was less than 1, RR was set to one.

A complete list of all the RRs chosen for each level of exposure and the source of these RRs is given in Table 1.

Table 1: Risk estimates used in the estimation of attributable fractions

Cancer	Exposure	High exposure Relative risk (95% confidence interval)	Low exposure Relative risk (95% confidence interval)	Relative Risk Source	Strength of evidence ^h
Bladder	Aromatic amines			Sorahan <i>et al.</i> (1998)	Strong
	Industrial chemicals/MBOCA manufacture	1.70 (1.05, 2.76)			
	Rubber products manufacture	1.89 (1.34, 2.66)			
	Plastic products manufacture	1.73 (1.17, 2.55)			
	Benzidine-based dye manufacture	2.61 (0.98, 7.00)			
	Laboratory technicians	1.05 (0.60, 1.86)			
	Medical and nursing	1.62 (1.03, 2.55)			
	Cable manufacturing	2.46 (1.20, 5.04)			
	Dyestuffs	2.61(0.98, 7.00)			
	Textile printing and dyeing	2.32 (0.98, 5.45)			
	Leather work	2.51(1.44, 4.35)			
	Diesel	1.24 (1.01, 1.41)	1.03 (0.84, 1.26)	High and Low: Boffetta and Silverman (2001)	Suggestive
	Hairdressers (males)	1.22 (0.98, 1.51)		Czene <i>et al.</i> (2003)	Suggestive
	Hairdressers (females)	1.09 (0.81, 1.43)		Czene <i>et al.</i> (2003)	Suggestive
	Mineral oils ^a	1.39 (1.20, 1.61)	1	High:Tolbert 1979	Suggestive
PAH	1.44 (1.20, 1.74)	1	High: Boffetta <i>et al.</i> (1997)	Strong	
Painters	1.17 (1.11, 1.23)		Bosetti <i>et al.</i> (2005)	Suggestive	
Bone	Ionising radiation ^b	1.03		UNSCEAR (2008)	Strong

Cancer	Exposure	High exposure Relative risk (95% confidence interval)	Low exposure Relative risk (95% confidence interval)	Relative Risk Source	Strength of evidence ^h
Brain	Inorganic lead ^a	1.06(0.8, 1.4)	1	High: Steenland and Bofetta (2000)	Suggestive
	Non arsenical insecticides				Suggestive
	Farmers	1.06 (1.02, 1.11)		Acquavella <i>et al.</i> (1998)	
	Pesticide manufacture	1.01 (0.75, 1.36)		Jones <i>et al.</i> (2008)	
	Petroleum refining	1.02 (0.83, 1.25)		Sorahan (2007)	Suggestive
Breast	Shift work	1.51 (1.36, 1.68)		Megdall <i>et al.</i> (2005)	Suggestive
	Flight personnel	1.44 (1.26, 1.65)		Megdall <i>et al.</i> (2005)	Suggestive
Cervix	Tetrachloroethylene ^c	1.95 (1.00, 3.40)	1.29 (0.18, 3.16)	High: Ruder <i>et al.</i> (2001)	Suggestive
Kidney	Trichloroethylene	1.2 (0.8, 1.7)	1	High: Wartenberg <i>et al.</i> (2000) Low: Morgan <i>et al.</i> (1998)	Suggestive
Larynx	Asbestos ^a	1.37 (1.17, 1.6)	1	High: Fortunato and Rushton (2012)	Suggestive
	Rubber manufacture	1.19 (0.82, 1.62)		Sorahan <i>et al.</i> (1989)	Suggestive
	Strong inorganic acid mists containing sulphuric acid	4.28 (2.13, 8.58)	1.91 (0.97, 3.78)	High: Steenland and Beaumont, 1989 Low: Coggon <i>et al.</i> (1996)	Strong
Leukaemia (Acute non-lymphatic leukaemia only)	Benzene		1.11 (0.3, 2.83)	Bloemen <i>et al.</i> (2004)	Strong
	Chemical manufacturing	2.17 (0.9, 5.20)		Collins <i>et al.</i> (2003)	
	Land transport	1.32 (0.49, 2.88)		Lewis <i>et al.</i> (2000)	
Leukaemia (except Chronic lymphatic leukaemia)	Ionising radiation ^b			UNSCEAR (2008)	Strong
	Aircrew	1.04			
	Other	1.03			
All Leukaemia	1,3 butadiene	2.3 (0.6, 8.3)	1.3 (0.4, 4.3)	High and Low: Delzell <i>et al.</i> (2001)	Suggestive
	Ethylene oxide		1	Teta <i>et al.</i> (1999)	Strong
	Chemical and other manufacture	2.29 (0.64, 6.02)		Coggon <i>et al.</i> (2004)	
	Medical workers	1.08 (0.03, 6.19)		Coggon <i>et al.</i> (2004)	
	Formaldehyde ^d				Suggestive

		High exposure	Low exposure		
Cancer	Exposure	Relative risk (95% confidence interval)	Relative risk (95% confidence interval)	Relative Risk Source	Strength of evidence^h
	Embalmers	1.6 (1.2, 2.0)		Collins and Lineker (2004)	
	Health and veterinary employees, research scientists	1.2 (0.8, 1.8)		Collins and Lineker (2004)	
	Non-arsenical insecticides				Suggestive
	Agricultural workers and farmers	1.1 (1.02, 1.18)		Acquavella <i>et al.</i> (1998)	
	Grain milling	1.07 (0.75, 1.47)		Alavanja <i>et al.</i> (1990)	
	Pesticide manufacturing	1.08 (0.81, 1.44)		Jones <i>et al.</i> (2009)	
Liver	Ionising radiation ^b	1.01		UNSCEAR (2008)	Strong
	Trichloroethylene	1.3 (1.09, 1.55)	1	High: Alexander <i>et al.</i> (2007)	Suggestive
	Vinyl chloride monomer ^c	2.86 (1.83, 4.25)	1.89 (0.32, 3.96)	High: Simonato <i>et al.</i> (1991)	Strong
Lung	Arsenic	2.05 (1.43, 2.85)	1.74 (0.75, 3.43)	High and Low: Lee-Feldstein (1986)	Strong
	Asbestos ^c	Not applicable			Strong
	Beryllium ^a	1.12 (0.99, 1.26)	1	High: Ward <i>et al.</i> (1992)	Strong
	Cadmium	1.19 (1.09, 1.29)	1	High: Verougstraete <i>et al.</i> (2003)	Strong
	Chromium	1.18 (1.12, 1.25)	1	High: Cole and Rodu (2005) Low: Crump <i>et al.</i> (2003)	Strong
	Cobalt	1.93 (1.03, 3.62)	1.3 (1.00, 1.66)	High and Low: Moulin <i>et al.</i> (1998)	Suggestive
	Diesel engine exhaust	1.47 (1.29, 1.67)	1.10 (0.70, 1.80)	High: Lipsett and Campleman (1999) Low: Coggon <i>et al.</i> , 1984	Suggestive
	Environmental tobacco smoke (males) ^a	1.29 (0.93, 1.78)	1	High: Zhong <i>et al.</i> (2000)	Strong
	Environmental tobacco smoke (females) ^a	1.15 (1.04, 1.28)	1	High: Zhong <i>et al.</i> (2000)	Strong

Cancer	Exposure	High exposure	Low exposure	Relative Risk Source	Strength of evidence ^h
		Relative risk (95% confidence interval)	Relative risk (95% confidence interval)		
	Ionising radiation (males) ^b	1.005		UNSCEAR (2008)	Strong
	Ionising radiation (females) ^b	1.021		UNSCEAR (2008)	Strong
	Inorganic lead ^a	1.14 (1.04, 1.73)	1	High: Steenland and Boffetta, 2000	Suggestive
	Mineral oils ^a		1		Strong
	Printers	1.58 (1.28, 1.95)		Tolbert (1997)	
	Other industries	1.08 (1.04, 1.11)		Tolbert (1997)	
	Nickel ^d			Seilkop and Oller (2003)	Strong
	Clydach Refinery	1.39 (0.92, 2.01)		Sorahan and Williams (2005)	
	Other exposed workers	1.03 (0.97, 1.10)		Seilkop and Oller (2003)	
	Painters	1.21 (1.12, 1.31)		Chen and Seaton (1998)	Strong
	Polycyclic Aromatic Hydrocarbons		1		Suggestive
	Manufacture of industrial chemicals, petroleum and coal products, non-metallic products; iron and steel industry; non-ferrous metal industry ^e			Armstrong <i>et al.</i> (2004)	
	(50%) <0.01 µg/m ³	1			
	(40%) 0.01- <0.75 µg/m ³	1.02 (1.01, 1.03)			
	(5%) 0.75- <2 µg/m ³	1.08 (1.04, 1.11)			
	(5%) 2+ µg/m ³	1.25 (1.13, 1.38)			
	Radon ^c	NA			Strong
	Silica	1.32 (1.24, 1.41)	1.00 (0.85, 1.30)	High: Kurihara and Wada (2004) Low: Steenland <i>et al.</i> (2001)	Strong
	Steel foundry workers	1.46 (1.34, 1.58)		Sorahan <i>et al.</i> (1994)	Strong
	Strong inorganic acid mists ^a	1.36 (0.97, 1.94)	1	High: Steenland and Beaumont (1989) Low: Coggon <i>et al.</i> (1996)	

Cancer	Exposure	High exposure Relative risk (95% confidence interval)	Low exposure Relative risk (95% confidence interval)	Relative Risk Source	Strength of evidence ^h
	TCDD (Dioxins)				Suggestive
	Agriculture and farming	1.03 (0.78, 1.04)		Kogevinas <i>et al.</i> (1997)	
	Pesticide manufacture	1.22 (1.05, 1.41)		Jones <i>et al.</i> (2009)	
	Pulp and paper manufacture	1.04 (0.96, 1.03)		McLean <i>et al.</i> (2006)	
	Other industries	1.12 (0.98, 1.28)		Kogevinas <i>et al.</i> (1997)	
	Tin miners	1.83 (1.48, 2.28)		Hodgson and Jones (1990)	Strong
	Welders	1.26 (1.20, 1.32)		Ambroise <i>et al.</i> (2006)	Strong
Lymphohaemato- poietic	1,3 butadiene	2.03 (1.35, 2.93)	1.05 (0.72, 1.46)	High and Low: Delzell (2006)	Suggestive
Melanoma of the eye	UV radiation (welders)	2.05 (1.20, 3.51)		Shah <i>et al.</i> (2005)	Suggestive
Multiple myeloma	Non-arsenical insecticides				Suggestive
	Grain milling	1.09 (0.99, 1.19)		Alavanja <i>et al.</i> (1990)	
	Agriculture and farming	1.01 (0.50, 1.81)		Acquavella <i>et al.</i> (1998)	
	Pesticide manufacture	1.26 (0.89, 1.77)		Jones <i>et al.</i> (2009)	
Nasopharynx	Formaldehyde ^d	2.10 (1.78, 9.13)	1	High: Hauptmann <i>et al.</i> (2004)	Suggestive
	Wood dust	2.40 (1.10, 4.50)	1	High: Demers <i>et al.</i> (1995)	Suggestive
Non-Hodgkin's Lymphoma	Hairdressers	1.20 (0.84, 1.66)		Boffetta <i>et al.</i> (1994)	Suggestive
	Non-arsenical insecticides				Suggestive
	Grain milling	1.00 (0.64, 1.48)		McLean <i>et al.</i> (2006)	
	Agriculture and farming	1.11 (1.05, 1.17)			
	Pesticide manufacture	1.98 (1.45, 2.69)		Jones <i>et al.</i> (2009)	
	TCDD (Dioxins)				Suggestive
	Pesticide manufacture	1.98 (1.45, 2.69)		Jones <i>et al.</i> (2009)	
	Paper and pulp manufacture	1.40 (0.60, 2.70)		McLean <i>et al.</i> (2006)	
	Other industries	1		Bodner <i>et al.</i> (2003)	
	Tetrachloroethylene ^a	1.39 (0.56, 2.86)	1	Ruder <i>et al.</i> (2001)	Suggestive
Trichloroethylene ^a	1.29 (1.00, 1.66)	1	Mandel <i>et al.</i> (2006)	Suggestive	

Cancer	Exposure	High exposure	Low exposure	Relative Risk Source	Strength of evidence ^h
		Relative risk (95% confidence interval)	Relative risk (95% confidence interval)		
Non-melanoma skin	Mineral oils ^{ad}	1.20 (0.67, 2.15)	1	High and Low: Mitropoulos and Norman (2005)	Strong
	Polycyclic Aromatic Hydrocarbons (coal tars and pitches)	1.74 (1.07, 2.65)		Partanen and Boffetta (1994)	Strong
	Solar radiation			Freedman <i>et al.</i> (2002)	Strong
	Mixed outdoor and indoor work	1.01 (0.93, 1.09)			
	Outdoor work	1.30 (1.14, 1.47)			
	Farming	1.15 (1.00, 1.32)			
Oesophagus	Soots	3.87 (1.93, 6.93)		Evanoff <i>et al.</i> (1993)	Suggestive
	Tetrachloroethylene ^c	2.47 (1.35, 4.14)	1.63 (0.24, 3.85)	Ruder <i>et al.</i> (2001)	Suggestive
Ovary	Hairdressers	1.18 (0.98, 1.40)		Boffetta <i>et al.</i> (1994)	Suggestive
Pancreas	Acrylamide ^d	1.85 (0.68, 4.03)	1.22 (0.66, 2.27)	High and Low: Marsh <i>et al.</i> (2007)	Suggestive
Sinonasal	Chromium ^c	5.18 (2.37, 11.30)	3.42 (0.42, 10.52)	High: Rosenman and Stanbury (1996)	Suggestive
	Formaldehyde (males) ^d	1.66 (1.27, 2.17)	1	High: Mannetje <i>et al.</i> (1999)	Suggestive
	Formaldehyde (females) ^d	1	1		Suggestive
	Leather dust	7.41 (3.83, 12.94)		Fu <i>et al.</i> (1996)	Strong
	Mineral oils ^{cd}	2.8 (1.4, 5.7)	1.85 (0.25, 5.31)		Suggestive
	Nickel	8.7 (1.05, 31.4)		Clydach Refinery: Grimstrud and Peto (2006)	Strong
	Wood ^c	3.1 (1.6, 5.6)	2.05 (0.28, 5.21)	High: Demers <i>et al.</i> (1995)	Strong
Soft tissue sarcoma	TCDD (dioxins)				Suggestive
	Agriculture and farming	1.03 (0.90, 1.17)		Acquavella <i>et al.</i> (1998)	
	Pesticide manufacture	1.13 (0.75, 1.70)		Jones <i>et al.</i> (2009)	
	Paper and pulp manufacture	1.13 (0.59, 1.98)		McLean <i>et al.</i> (2006)	
	Other industry	2.03 (0.75, 4.43)		Kogevinas <i>et al.</i> (1997)	

Cancer	Exposure	High exposure	Low exposure	Relative Risk Source	Strength of evidence ^h
		Relative risk (95% confidence interval)	Relative risk (95% confidence interval)		
Stomach	Asbestos (males)	1.66 (1.49, 1.86)	1.21 (1.06, 1.38) ^g	High: Harding <i>et al.</i> (2009) Low: Fortunato and Rushton (2012)	Suggestive
	Asbestos (females)	1	1	Fortunato and Rushton (2012)	Suggestive
	Inorganic lead ^a	1.33 (1.18, 1.49)	1	High: Fu and Boffetta (1995)	Suggestive
	Painters	1.27 (1.01, 1.60)		Chen and Seaton (1998)	Suggestive
	Rubber industry	1.13 (1.02, 1.25)		Sorahan <i>et al.</i> (1989)	Suggestive
Thyroid	Ionising radiation ^b	1.09		UNSCEAR (2006)	Strong

^a Insufficient dose-response data; risk estimate for low exposure based on harmonic mean of the high/low ratios across all other cancer-exposure pairs in the overall project where data were available; this was < 1, hence risk estimate for low set to 1.

^b Confidence Intervals not estimated for cancers attributed to ionizing radiation, as they are not yet available for the excess relative risk models used (UNSCEAR 2008)

^c Insufficient dose-response data; risk estimate for low exposure based on harmonic mean of the high/low ratios across all other cancer-exposure pairs in the overall project where data were available

^d In addition to risk estimates for high and low exposure, a risk estimate of 1 was used for background exposure

^e Asbestos and radon estimated using different methodology from the standard method, see Hutchings and Rushton (2011)

^f High exposure subdivided by categories of 8 hour Time Weighted Average (TWA) benzo-a-pyrene (BaP) levels

^g Estimated from the meta-analysis by Fortunato and Rushton (2012) omitting the study by Harding *et al.* (2009)

^h Strength of evidence for carcinogenicity as assessed by Siemiatycki *et al.* (2004)

2.3 EXPOSED POPULATION ESTIMATION

The period during which exposure occurred that was relevant to the development of the cancer in the target year 2005 was defined as the risk exposure period (REP). For solid tumours a latency of 10-50 years was assumed giving a REP of 1956-1995; for haematopoietic neoplasms 0-20 year's latency was assumed giving a REP of 1986-2005. The proportion of the population ever exposed to each carcinogenic agent or occupation in the REP was obtained from the ratio of the numbers ever exposed to the carcinogens of interest in each relevant industry/occupation within GB over the total number of people ever employed (Equation 4 in the Statistical Appendix).

If the study from which the risk estimates were obtained was population based, an estimate of the proportion of the population exposed was derived directly from the study data, although such studies were rarely available in practice for GB. If the risk estimate was obtained from an industry-based study, national data sources such as the CARcinogen EXposure database (CAREX) (Pannett *et al.*, 1998), the UK Labour Force Survey (LFS) (LFS, 2009) and Census of Employment (ONS, 2009) were used. CAREX was used for estimating the numbers of the GB population ever exposed to a carcinogen by industry sector. As highlighted above data are not available on the levels of exposure in all industry sectors for all the carcinogens considered, nor the numbers exposed at these levels. The industry sectors were thus allocated to 'higher' or 'lower' exposure categories assuming distributions of exposure and risk that corresponded broadly to those of the studies from which the risk estimates were selected. The initial allocations were based on the judgment of an experienced human exposure scientist; each assessment was then independently peer-reviewed and if necessary, a consensus assessment agreed. Data from CAREX are not differentiated by sex; 1991 Census data by industry and occupation were used to estimate the relative proportions of men and women exposed. The LFS and Census of Employment data were used to estimate numbers ever employed in specific occupations e.g. welder, painter etc., and for specific industries for carcinogens not included in CAREX.

CAREX data for GB relate only to the period 1990-93. For the LFS and CoE an available year was chosen to represent numbers employed about 35 years before the target year of 2005, as this was thought to represent a 'peak' latency for the solid tumours, and is also close to the mid-point of the REP for estimating numbers ever exposed across the period (for which a linear change in employment levels was implicitly assumed). Where the Census of Employment was used, the data are for 1971. Where the LFS was used, the first year available used was 1979 for solid tumours, and 1991 for short latency cancers.

When CAREX data were used adjustment factors were applied to take account of the change in numbers employed in the primary and manufacturing industry and service sectors in GB over the REP. Adjustment for employment turnover over the period for grouped main industry sectors was also carried out (see equation 3 in the Statistical Appendix). Ideally this requires full national starter and leaver data across the REP for all industry sectors. In the absence of this quality of data, estimating turnover directly using new starters in years within the REPs gives the best approximation for the purpose of estimating those ever exposed. This method estimates starters in the past year as a proportion of the average number employed (Gregg and Wadsworth, 2002). As exposure in occupational epidemiological studies is usually defined as at least one year, we have adapted this to exclude short-term labour turnover. New starters in the past year who are expected to remain employed for at least one year were taken as a proportion of all those expected to be employed for at least 1 year. This was estimated as the number recorded as employed for between 1 and 2 years divided by the total employed for at least one year using LFS data averaged over the REP.

2.4 STATISTICAL ANALYSIS

The AFs have been calculated on a ‘cancer by cancer’ basis. To estimate the AFs for each cancer/occupational carcinogen Levin’s method was used if risk estimates came from an industry-based study or a review or meta-analysis together with estimates of the proportion of the population exposed from independent national sources of data (Levin, 1953). Miettinen’s method was used if risk estimates and proportion of cases exposed came from a population-based study (Miettinen, 1974) (equations 1 and 2 respectively in the Statistical Appendix). For each AF, a random error confidence interval was calculated using Monte Carlo simulations (Steenland and Armstrong, 2006). The AFs were applied to total numbers of cancer specific deaths (2005) and cancer registrations (2004) for ages that could have been exposed during the REP to give attributable numbers. Where risk estimates were only available from mortality studies AFs derived from these were used for estimation of attributable registrations and vice versa. Similarly if separate AFs for women could not be estimated those for men or for men and women combined were used.

The AF for mesothelioma was derived directly from several UK mesothelioma studies that suggest between 96% and 98% of male mesothelioma cases are due to occupational or paraoccupational (e.g. exposure from living near an asbestos factory or handling clothes contaminated due to occupational exposure) exposure (Yates *et al*, 1997; Howel *et al*, 1997; Rake *et al*, 2009). Combining the results from Rake *et al* (2009) with those from two studies in which results were reported separately for females (Goldberg *et al*, 2006; Spirtas *et al*, 1994) gave estimates of 75%-90% for females. The ratio of asbestos related lung cancer to mesothelioma deaths has been suggested to be between two-thirds and one (Darnton *et al*, 2006). Rather than using our standard method for the estimation of numbers of lung cancers attributable to asbestos, we therefore used a ratio of 1:1, lung cancer to mesothelioma deaths. This takes into account the impact that past levels of exposure to asbestos are having on the current incidence by the direct link to mesothelioma deaths that are still climbing whereas lung cancer in general is declining due to the reduction in smoking. This assumes, however, that lung cancer has a similar pattern of latency as mesothelioma. The total lung cancers attributable to asbestos were allocated between industries by using estimates of relative risk for ‘higher’ and ‘lower’ level exposed (from Goodman *et al*, 1999) and proportions ever exposed by industry sector (based on CAREX) combined as weights.

For lung cancer associated with radon exposure from natural sources, estimates of rates of lung cancer due to exposure to radon in domestic buildings (NRPB 2000) were applied to estimates of the time employees spend in workplaces where radon exposure occurs.

AFs for all the relevant carcinogenic agents and occupational circumstances were combined into a single estimate of AF for each separate cancer. To take account of potential multiple exposures, strategies including partitioning exposed numbers between overlapping exposures or estimating only for the ‘dominant’ carcinogen with the highest risk were used. The IARC Monograph process has been taking place over many years and has resulted in overlap between substances evaluated. For lung cancer, for example, there are 32 occupations or carcinogenic agents evaluated by IARC. AFs were estimated for 21 of these; for example, substances such as coal-tars and pitches and processes such as coal gasification and coke production were included within our evaluation of Polycyclic Aromatic Hydrocarbons (PAH). Where exposure to multiple carcinogens remained it was assumed that the exposures were independent of one another and that their joint carcinogenic effects were multiplicative. The AFs were then combined to give an overall AF for that cancer using a product sum (equation 5 in the Statistical Appendix). An overall AF for all cancers was estimated by summing the attributable numbers for each, and dividing by the total number of cancers in GB.

3.0 RESULTS

The study has quantified for the first time the impact of occupation on the burden of cancer in Britain for all cancer sites and the carcinogens which IARC have classified as having sufficient (group 1) or limited (group 2A) evidence in humans. Estimates of attributable fractions, attributable numbers of deaths (for 2005) and attributable numbers of cancer registrations (for 2004) have been made for:

1. for males and female separately and for the total;
2. for 24 separate cancer sites and the total
3. for 41 separate carcinogens or occupational circumstances
4. for over 60 separate industry sectors.

This report presents summary tables for these results. More detailed results are available in MS Excel tables on the HSE website and will be available in the technical reports for the individual cancer sites.

3.1 ATTRIBUTABLE FRACTIONS AND NUMBERS BY CANCER SITE

The overall burden by cancer site (AFs, attributable numbers (ANs) and 95% confidence intervals) is given in Table 2A together with the International Classification of Disease (ICD) version 10 codes for each cancer site. 8.2% (n = 6355) of cancer deaths in 2005 in men and 2.3% (n = 1655) in women in Britain have been estimated to be due to occupation giving an overall AF of 5.3% (n = 8010). The combined AFs for registrations are 5.7% (n = 9988) for men in 2004 and 2.1% (n = 3611) for women giving an overall AF based on registrations of 4.0% (n = 13598).

If only agents and occupations classified by IARC as group 1 and having strong evidence of carcinogenicity in humans are considered, the overall burden reduces to 3.8% (5986 total deaths, 9590 total registrations) (Table 2B). Only 9 cancer sites are involved (bladder, larynx, leukaemia, liver, lung, mesothelioma, NMSC, sinonasal and thyroid). The dominance of asbestos exposure and mesothelioma, asbestos and the many other group 1 carcinogens affecting lung cancer and solar radiation and NMSC means that the reduction in the AF and attributable numbers for men (6.3%, 5123 deaths, 8277 registrations) is far less than for women (1.0%, 862 deaths, 1313 registrations) for whom shift work is most dominant.

In general, attributable fractions and numbers are higher for men than for women, due mainly to the higher proportions of males exposed to occupational carcinogens. The difference between the numbers of attributable deaths and registrations reflects the varying survival from cancer with mortality and registration numbers being similar for poor survival cancers such as lung cancer and mesothelioma; in contrast the difference is much greater for cancers such as breast cancer where survival is improving and for NMSC, which is rarely fatal.

The AFs by cancer site range from less than 0.01% to 95% overall, the most important cancer sites for occupational attribution being, for men, mesothelioma (97%), sinonasal (43.3%), lung (21.1%), bladder (7.1%) and NMSC (6.9%), and for women mesothelioma (82.5%) sinonasal (19.8%), lung (5.3%), breast (4.6%) and nasopharynx (2.4%). Occupation also contributes 2% or more overall to cancers of the larynx, oesophagus and soft tissue sarcoma (STS), with in addition for men melanoma of the eye (due to welding), non-Hodgkin's lymphoma (NHL) and stomach.

Lung cancer contributes the largest number of attributable deaths for both men and women followed, for men, by mesothelioma, bladder, oesophageal and stomach cancers, and for women,

by breast cancer, mesothelioma, bladder and oesophageal cancers. For attributable numbers of cancer registrations, the patterns differ between men and women; for men, lung cancer contributes the largest numbers of registrations followed by NMSC, mesothelioma, bladder, oesophageal and stomach cancers, non-Hodgkin's lymphomas and sinonasal cancer; for women breast cancer contributes the largest numbers of registrations followed by lung cancer, NMSC, mesothelioma, bladder cancer, non-Hodgkin's lymphoma, ovarian, sinonasal and oesophageal cancers.

Table 2A Estimated attributable fractions, deaths and registrations by cancer site in 2005 (deaths) and 2004 (registrations)

Cancer Site	ICD-10 code	Attributable Fraction (%)			Attributable Numbers					
		(95% Confidence Interval)			(95% Confidence Interval)					
					Deaths (2005)			Registrations (2004)		
	ICD-10 code	Male	Female	Total (Based on Deaths)	Male	Female	Total	Male	Female	Total
Bladder	C67	7.1 (4.6, 9.7)	1.9 (1.3, 3.9)	5.3 (3.4, 7.7)	215 (139, 296)	30 (21, 62)	245 (159, 358)	496 (321, 684)	54 (37, 110)	550 (357, 795)
Bone	C40-C41	0.04	0.01	0.02	0	0	0	0	0	0
Brain	C70-C72	0.5 (0.1, 1.1)	0.1 (0, 0.2)	0.3 (0.0, 0.7)	10 (1, 20)	1 (0, 3)	11 (1, 23)	12 (1, 25)	2 (0, 4)	14 (1, 28)
Breast	C50		4.6 (3.3, 6.0)	4.6 (3.3, 6.0)		555 (397, 727)	555 (397, 727)		1969 (1407, 2579)	1969 (1407, 2579)
Cervix	C53		0.7 (0.0, 2.1)	0.7 (0.0, 2.1)		7 (0, 22)	7 (0, 22)		18 (1, 56)	18 (1, 56)
Kidney	C64-C66, C68	0.04 (0, 0.16)	0.04 (0, 0.14)	0.04 (0, 0.15)	1 (0, 3)	1 (0, 2)	1 (0, 5)	2 (0, 7)	1 (0, 4)	3 (0, 10)
Larynx	C32	2.9 (1.4, 5.7)	1.6 (0.6, 3.5)	2.6 (1.2, 5.2)	17 (8, 34)	3 (1, 6)	20 (9, 40)	50 (24, 99)	6 (2, 13)	56 (26, 112)
Leukaemia ^a	C91-C95	0.9 (0.2, 3.5)	0.5 (0.1, 4.5)	0.7 (0.2, 3.9)	18 (4, 71)	5 (1, 49)	23 (5, 120)	30 (7, 118)	9 (1, 80)	38 (8, 198)
Liver	C22	0.2 (0.1, 0.3)	0.1 (0.1, 0.2)	0.2 (0.1, 0.3)	4 (2, 6)	2 (1, 2)	5 (3, 8)	4 (2, 6)	1 (1, 2)	5 (3, 8)
Lung	C33-C34	21.1 (19.2, 24.7)	5.3 (4.3, 6.9)	14.5 (13.0, 17.2)	4020 (3659, 4696)	725 (592, 946)	4745 (4251, 5643)	4627 (4212, 5406)	815 (666, 1063)	5442 (4877, 6469)
Lympho-haematopoietic	C81-C96	0.004 (0, 0.014)	0.002 (0, 0.007)	0.003 (0, 0.011)	0 (0, 1)	0 (0, 0)	0 (0, 1)	0 (0, 1)	0 (0, 0)	1 (0, 2)

Cancer Site		Attributable Fraction (%)			Attributable Numbers					
		(95% Confidence Interval)			(95% Confidence Interval)					
					Deaths (2005)			Registrations (2004)		
	ICD-10 code	Male	Female	Total (Based on Deaths)	Male	Female	Total	Male	Female	Total
Melanoma (eye)	C69	2.9 (0.6, 6.6)	0.4 (0.1, 1.0)	1.6 (0.3, 3.6)	1 (0, 3)	0 (0, 0)	1 (0, 3)	6 (1, 13)	1 (0, 2)	6 (1, 15)
Mesothelioma	C45	97.0 (96.0, 98.0) ^b	82.5 (75.0, 90.0) ^b	94.9 (93.0, 96.9) ^b	1699 (1681, 1717)	238 (216, 260)	1937 (1898, 1976)	1699 (1681, 1717) ^c	238 (216, 260) ^c	1937 (1898, 1976) ^c
Multiple Myeloma	C90	0.4 (0, 1.0)	0.1 (0, 0.3)	0.3 (0, 0.7)	5 (0, 10)	1 (0, 2)	6 (0, 12)	8 (0, 18)	2 (0, 3)	10 (0, 21)
Nasopharynx	C11	10.8 (2.3, 47.9)	2.4 (0.6, 6.8)	8.0 (1.8, 34.3)	7 (2, 31)	1 (0, 2)	8 (2, 33)	14 (3, 61)	1 (0, 4)	15 (3, 65)
NHL	C82-C85	2.1 (0, 6.9)	1.1 (0.1, 2.9)	1.7 (0, 5.4)	43 (0, 138)	14 (1, 37)	57 (1, 176)	102 (0, 328)	39 (3, 101)	140 (3, 430)
NMSC ^d	C44	6.9 (1.3, 15.0)	1.1 (0.0, 2.9)	4.5 (0.8, 9.9)	20 (4, 44)	2 (0, 6)	23 (4, 50)	2513 (478, 5447)	349 (0, 899)	2862 (478, 6346)
Oesophagus	C15	3.3 (1.5, 7.5)	1.1 (0.3, 2.8)	2.5 (1.1, 5.9)	156 (70, 358)	28 (8, 70)	184 (78, 429)	159 (71, 365)	29 (9, 74)	188 (80, 439)
Ovary	C56		0.5 (0, 1.2)	0.5 (0, 1.2)		23 (0, 52)	23 (0, 52)		33 (0, 76)	33 (0, 76)
Pancreas	C25	0.02 (0, 0.07)	0.01 (0, 0.04)	0.01 (0, 0.05)	1 (0, 2)	0 (0, 1)	1 (0, 4)	1 (0, 2)	0 (0, 1)	1 (0, 4)
Sinonasal	C30-C31	43.3 (27.3, 74.0)	19.8 (14.4, 31.6)	32.7 (21.5, 54.8)	27 (17, 47)	10 (8, 16)	38 (25, 63)	95 (60, 162)	31 (23, 50)	126 (83, 212)
STS	C49	3.4 (0, 11.4)	1.1 (0, 3.8)	2.4 (0, 8.1)	11 (0, 36)	3 (0, 9)	13 (0, 45)	22 (0, 75)	4 (0, 15)	27 (0, 90)
Stomach	C16	3.0 (1.5, 5.1)	0.3 (0.1, 0.5)	1.9 (1.0, 3.4)	101 (52, 176)	6 (3, 11)	108 (55, 187)	149 (77, 258)	9 (4, 15)	157 (81, 274)

Cancer Site		Attributable Fraction (%)			Attributable Numbers					
		(95% Confidence Interval)			(95% Confidence Interval)					
					Deaths (2005)			Registrations (2004)		
	ICD-10 code	Male	Female	Total (Based on Deaths)	Male	Female	Total	Male	Female	Total
Thyroid	C73	0.12	0.02	0.05	0	0	0	0	0	1
Total:	C00-C97									
Total based on deaths		8.2 (7.2, 9.9)	2.3 (1.7, 3.2)	5.3 (4.6, 6.6)	6,355 (5640, 7690)	1,655 (1249, 2287)	8,010 (6888, 9977)			
Total based on registrations		5.7 (4.0, 8.4)	2.1 (1.4, 3.2)	4.0 (2.7, 5.9)				9,988 (6938, 14794)	3,611 (2370, 5412)	13,598 (9308, 20206)
Total cancers in GB in ages 15+					77,912	72,212	150,124	175,399	168,184	343,583

Abbreviations: ICD = International Classification of Diseases; NHL = non-Hodgkin's lymphoma; NMSC=non-melanoma skin cancer; STS = soft tissue sarcoma

^aAF applicable to all leukaemias

^bIncludes cases described as due to paraoccupational or environmental exposure to asbestos.

^cTaken as equal to attributable deaths for this short survival cancer.

^d Based on registrations

CI's were not estimated for bone and thyroid cancers and other cancers attributed to ionizing radiation, as CI estimates are not yet available for the excess relative risk models used (UNSCEAR 2006)

Totals do not always sum across rows due to rounding error

Table 2B Estimated attributable fractions, deaths and registrations by cancer site in 2005 (deaths) and 2004 (registrations) for agents and occupations classified as IARC group 1 with 'strong' evidence of carcinogenicity in humans

Cancer Site	Attributable Fraction (%) (95% Confidence Interval)			Attributable Numbers (95% Confidence Interval)					
				Deaths (2005)			Registrations (2004)		
	Male	Female	Total (Based on Deaths)	Male	Female	Total	Male	Female	Total
Bladder	0.8 (0.7,3.0)	0.6 (0.5,2.9)	0.7 (0.7,3.0)	24 (20, 91)	10 (9, 39)	34 (29, 130)	55 (47, 211)	18 (16, 70)	73 (63, 280)
Bone	0	0	0	0	0	0	0	0	0
Brain	0	0	0	0	0	0	0	0	0
Breast		0	0		0	0		0	0
Cervix	0	0	0	0	0	0	0	0	0
Kidney	0	0	0	0	0	0	0	0	0
Larynx	2.3 (0.8,5.1)	1.5 (0.5, 3.4)	2.1 (0.8, 4.8)	14 (5, 31)	2 (1, 5)	16 (6, 37)	40 (15, 89)	6 (2, 12)	46 (17, 102)
Leukaemia ^a	0.1 (0, 2.0)	0.2 (0, 3.9)	0.2 (0, 2.6)	3 (0, 40)	2 (0, 36)	5 (1, 75)	5 (1, 70)	4 (0, 55)	8 (1, 124)
Liver	0.1 (0.1,0.3)	0.1 (0, 0.1)	0.1 (0.1, 0.2)	2 (1, 4)	1 (0, 2)	3 (2, 6)	2 (1, 4)	1 (0, 2)	3 (2, 6)
Lung	17.6 (15.5, 19.4)	4.4 (3.5, 5.4)	12.0 (10.2, 13.9)	3346 (2945,3687)	599 (527,660)	3945 (3472,4347)	3851 (3390,4244)	673 (592, 742)	4524 (3983, 4985)
Lympho-haematopoietic	0	0	0	0	0	0	0	0	0
Melanoma (eye)	0	0	0	0	0	0	0	0	0
Mesothelioma	97.0 (96.0, 98.0) ^b	82.5 (75.0, 90.0) ^b	94.9 (93.0, 96.9)	1699 (1681, 1717)	238 (216, 260)	1937 (1898, 1976)	1699 (1681, 1717) ^c	238 (216, 260) ^c	1937 (1898, 1976) ^c
Multiple Myeloma	0	0	0	0	0	0	0	0	0
Nasopharynx	0	0	0	0	0	0	0	0	0

Cancer Site	Attributable Fraction (%) (95% Confidence Interval)			Attributable Numbers (95% Confidence Interval)					
				Deaths (2005)			Registrations (2004)		
	Male	Female	Total (Based on Deaths)	Male	Female	Total	Male	Female	Total
NHL	0	0	0	0	0	0	0	0	0
NMSC ^d	6.9 (1.3, 15.0)	1.1 (0.0, 2.9)	4.5 (0.8, 9.9)	20 (4, 44)	2 (0, 6)	23 (4, 50)	2513 (478, 5447)	349 (0, 899)	2862 (478, 6346)
Oesophagus	0	0	0	0	0	0	0	0	0
Ovary	0	0	0	0	0	0	0	0	0
Pancreas	0	0	0	0	0	0	0	0	0
Sinonasal	21.0 (11.8, 34.7)	13.6 (8.2, 22.5)	17.7 (10.2, 29.2)	13 (7, 22)	7 (4, 12)	20 (11, 34)	46 (26, 76)	22 (12, 36)	68 (38, 112)
STS	0	0	0	0	0	0	0	0	0
Stomach	0	0	0	0	0	0	0	0	0
Thyroid	0.1	0	0	0	0	0	1	0	1
Total Based on deaths	6.6 (6.0, 7.2)	1.2 (1.0, 1.4)	4.0 (3.6, 4.4)	5121 (4665, 5635)	862 (758, 1020)	5983 (5417, 6618)			
Total Based on registrations	4.7 (3.2, 6.8)	0.8 (0.5, 1.2)	2.8 (1.9, 4.1)				8212 (5640, 11858)	1310 (840, 2075)	9522 (6480, 13933)
Total cancers in GB in ages 15+				77912	72212	150124	175399	168184	343583

NHL = Non-Hodgkin's lymphoma; NMSC = non-melanoma skin cancer; STS = soft tissue sarcoma

^a AF applicable to all leukaemias

^b Includes cases described as due to paraoccupational or environmental exposure to asbestos.

^c Taken as equal to attributable deaths for this short survival cancer.

^d Based on registrations.

Totals do not always sum across rows due to rounding error

Confidence Intervals not estimated for cancers attributed to ionizing radiation, as they are not yet available for the excess relative risk models used (UNSCEAR 2006)

3.2 ATTRIBUTABLE FRACTIONS, DEATHS AND REGISTRATIONS BY CARCINOGEN AND CANCER SITE

Tables 3, 4 and 5 give attributable fractions, total deaths and total registrations respectively, by cancer site and for each carcinogenic agent or occupational circumstance, together with a ranking by total carcinogenic agent. 95% confidence intervals for these figures, numbers of deaths and registrations for males and females and their 95% confidence intervals are available on the HSE website, together with the attributable fractions and their 95% confidence intervals.

Asbestos contributes the most to the attributable burden from occupational carcinogens with 2.6% of all cancers (based on deaths) in the GB population being attributable to occupational asbestos exposure (Table 3). This is followed by silica (0.53%), diesel engine exhaust (DEE) (0.43%), mineral oils (0.38%), shift work (0.37%), work as a painter (0.22%), environmental tobacco smoke (ETS) (0.17%), TCDD (dioxins) (0.15%), naturally occurring radon (0.12%), work as a welder (0.10%).

The first two results columns of Table 3 give the proportion of the population ever exposed occupationally to the carcinogens over the risk exposure period (REP) with long latency proportions relating to solid tumours and the short latency proportions relating to cancers such as leukaemia, lymphoma etc. 13.7% of the population were ever exposed occupationally to solar radiation followed by mineral oils (up to 15%), TCDD (7.7%), silica (6.9%), naturally occurring radon in the workplace (6.4%), ETS (5.6%), wood dust (5.3%), DEE (5.1%), non-arsenical insecticides (4.3%) and inorganic lead (3%).

Asbestos also contributes the most to total attributable deaths (Table 4) (larynx (3), lung (1937), mesothelioma (1937), stomach (32)), followed by silica (lung (789)), diesel engine exhaust (DEE (605)), mineral oils (bladder (131), lung (410), sinonasal (16)), shift work (breast (552), work as a painter (bladder (31), lung (246), stomach(57)), environmental tobacco smoke (ETS) encountered at work in non-smokers (lung (249)), dioxins (TCDD) (lung (187)), radon exposure from natural exposure in workplaces (lung (184)), and work as a welder (lung (152)).

Fifteen of the carcinogens contributed over 100 total cancer registrations (Table 5), the largest being asbestos exposure (mesothelioma (1937) and lung (1937) larynx (8) and stomach cancers (47)), followed in order by shift work, including flight personnel (breast (1957)), mineral oils (bladder (296), lung (470), NMSC (902), sinonasal (55)), solar radiation (SR) (NMSC (1541)), silica (lung (907)), diesel engine exhaust (DEE) (lung (695), bladder (106)), PAHs from coal tar and pitches (NMSC (475)), occupation as a painter (bladder (71), lung (282), stomach (83)), dioxins (lung (215), NHL (74), STS (27)), ETS (lung (284)), radon (lung (209)), occupation as a welder (lung (175), melanoma of the eye due to UV radiation (6)), tetrachloroethylene (cervix (18), NHL (17), oesophagus (130)), arsenic (lung (129)) and strong inorganic acid mists (larynx (46), lung (76)).

The results in these tables highlight the fact that many carcinogenic exposures in the workplace affect multiple cancer sites.

Table 3 Proportion of the population ever exposed and attributable fractions (%) by carcinogenic agent or occupational circumstance and cancer site

Agent	Proportion of the population ever exposed (%)		Cancer Site												
	Solid tumours	Short latency cancers	Bladder	Bone	Brain	Breast	Cervix	Kidney	Larynx	Leukaemia	Liver	Lung	LH	Melanoma eye	Mesothelioma
1,3-Butadiene		0.02								0.01			0.00		
Acrylamide	0.04														
Aromatic amines	0.48		0.67												
Arsenic	0.34											0.34			
Asbestos	1.07								0.37			5.91			95.09
Benzene		2.27								0.25					
Beryllium	0.15											0.02			
Cadmium	0.47											0.02			
Chromium VI	1.71, 1.70 ⁽¹⁾											0.18			
Cobalt	0.48											0.19			
Diesel engine exhaust	5.11, 5.09 ⁽¹⁾		1.00									1.84			
Ethylene oxide		0.02								0.01					
ETS	5.65											0.76			
Flight personnel	0.03 ⁽⁸⁾					0.03									
Formaldehyde	1.30	0.59								0.20					
Hairdressers and barbers	1.80 ⁽⁹⁾	0.98	0.16												
Inorganic lead	3.02, 2.97 ⁽¹⁾ 3.01 ⁽¹⁰⁾				0.05							0.11			
Ionising radiation	0.72 ⁽⁷⁾	0.40 ⁽⁷⁾		0.02						0.02	0.01	0.01			
Leather Dust	1.49														
Mineral oils	14.39 12.11,		2.81									1.25			

Agent	Proportion of the population ever exposed (%)		Cancer Site												
	Solid tumours	Short latency cancers	Bladder	Bone	Brain	Breast	Cervix	Kidney	Larynx	Leukaemia	Liver	Lung	LH	Melanoma eye	Mesothelioma
	13.23 ⁽²⁾														
Nickel	1.17, 0.0004 ⁽⁶⁾											0.02			
Non-arsenical insecticides	4.29	3.27			0.29					0.38					
PAHs	1.29, 1.22 ⁽¹⁾		0.07									0.003			
PAHs - Coal tars and pitches	0.86														
Painters	3.09		0.67									0.75			
Petroleum refining	0.35				0.01										
Radon	6.44											0.56			
Rubber industry	0.52								0.12						
Shift work	4.84 ⁽¹¹⁾					4.53									
Silica	6.88											2.41			
Solar radiation	13.66														
Soots	0.21														
Steel foundry workers	0.14											0.08			
Strong inorganic-acid mists containing sulphuric acid	0.61, 0.58 ⁽¹⁾								2.13			0.20			
TCDD	7.73 ⁽³⁾	2.41, 5.93 ⁽⁴⁾										0.57			
Tetrachloroethylene	1.39 ⁽¹²⁾	0.81					0.68								
Tin miners	0.001 ⁽⁵⁾											0.00			
Trichloroethylene	0.21	0.11						0.04				0.06			

Agent	Proportion of the population ever exposed (%)		Cancer Site												
	Solid tumours	Short latency cancers	Bladder	Bone	Brain	Breast	Cervix	Kidney	Larynx	Leukaemia	Liver	Lung	LH	Melanoma eye	Mesothelioma
UV	1.55													1.56	
Vinyl chloride	0.06										0.11				
Welders	1.55											0.46			
Wood dust	5.32														
Total AF(%)			5.38	0.02	0.35	4.56	0.68	0.04	2.61	0.74	0.18	14.47	0.00	1.56	95.09

LH= Lymphohaematopoietic; PAH = polycyclic aromatic hydrocarbon; TCDD = 2,3,7,8-Tetrachlorodibenzodioxin; UV = ultra violet

(1) 'Iron and steel basic industries' have been excluded from the CAREX industry sectors for all relevant carcinogens when estimating lung cancer to avoid overlap with the separate estimate for steel foundry workers.

(2) For mineral oils different paths of exposure were recognised (dermal and inhalation), and therefore some industries were excluded from the estimates for the different cancer sites. The highest estimate (14.39%) is for NMSC, which is for dermal exposure only; lung (13.23%), bladder and sinonasal cancers (both 12.11%) exclude solely dermal exposure (motor mechanics, office machinery mechanics and aircraft engine maintenance fitters). Printers were included (with a high level relative risk) in the estimates for lung cancer, but excluded for the other cancer sites.

(3) For TCDD (long latency) the estimates for lung cancer from LFS 1979 data include farming, forestry and horticulture

(4) For TCDD (short latency) the estimates for STS (5.93%) from Census of Employment data are used which include farming, forestry and horticulture; (excluded for NHL, 2.41%)

(5) For tin miners the number shown here was for the whole cohort employed from 1941, not a point estimate.

(6) For lung cancer from nickel exposure the number shown here for non-ferrous metals basic industries is from CAREX (1.17%). For sinonasal cancer for which only high level exposure was considered to have excess risk, numbers for the Clydach cohort only were used (0.0004%).

(7) For Ionising Radiation exposure data were obtained from the Central Index of Dose Information (CIDI, 1998) which excludes air crew, plus data from the LFS for male flight crew and from a cohort of women flight crew from the BA Stewards and Stewardesses Union (BASSA) data.

(8) 0.03% is the proportion ever exposed for men and women together; flight personnel as an exposure was estimated for women's breast cancer only; the proportion of women ever flight personnel is 0.07%, estimated using the BASSA cohort

(9) Estimation for hairdresser and ovarian cancer was for women only; the proportion of women ever hairdressers is 3.01%

(10) For inorganic lead the estimates for stomach cancer (3.01%) exclude the rubber industry to avoid double counting

⁽¹¹⁾4.84% is for men and women together. Estimates were made for shift work and women's breast cancer only; the proportion of women in shift (night) work is 0.093%

⁽¹²⁾ Estimation for tetrachloroethylene and cervical cancer was for women only; the proportion of women ever exposed to tetrachloroethylene is 0.90%

Table 3: Continued: Attributable fraction (%) by carcinogenic agent or occupational circumstance and cancer site

Agent	MM	Nasopharynx	NHL	NMSC	Oesophagus	Ovary	Pancreas	Sinonasal	STS	Stomach	Thyroid	Total across all cancer sites (based on deaths)	Rank
1,3-Butadiene												0.00	40
Acrylamide							0.01					0.00	38
Aromatic amines												0.02	20
Arsenic												0.08	12
Asbestos										0.58		2.6	1
Benzene												0.00	30
Beryllium												0.00	28
Cadmium												0.01	25
Chromium VI								5.69				0.04	14
Cobalt												0.04	15
Diesel engine exhaust												0.43	3
Ethylene oxide												0.00	41
ETS												0.17	7
Flight personnel												0.00	34
Formaldehyde		0.44						0.17				0.00	27
Hairdressers and barbers			0.19			0.54						0.02	19
Inorganic lead										0.28		0.04	17
Ionising radiation											0.05	0.00	36
Leather Dust								8.39				0.01	24
Mineral oils				1.42				13.84				0.38	4
Nickel								0.00				0.01	26
Non-arsenical insecticides	0.03		0.38									0.03	18
PAHs												0.00	32
PAHs - Coal tars and pitches				0.76								0.00	33
Painters										1.03		0.22	6
Petroleum refining												0.00	42
Radon												0.12	9

Agent	MM	Nasopharynx	NHL	NMSC	Oesophagus	Ovary	Pancreas	Sinonasal	STS	Stomach	Thyroid	Total across all cancer sites (based on deaths)	Rank
Rubber industry										0.08		0.00	29
Shift work												0.37	5
Silica												0.53	2
Solar radiation				2.41								0.01	23
Soots					0.81							0.04	16
Steel foundry workers												0.02	21
Strong inorganic-acid mists containing sulfuric acid												0.06	13
TCDD			0.86						2.27			0.15	8
Tetrachloroethylene			0.20		1.74							0.09	11
Tin miners												0.00	39
Trichloroethylene			0.03									0.00	31
UV												0.00	37
Vinyl chloride												0.00	35
Welders												0.10	10
Wood dust		7.62						10.02				0.01	22
Total Attributable fraction (%)	0.03	8.03	1.74	4.50	2.54	0.54	0.01	32.67	2.27	1.95	0.00	5.34	

MM = multiple myeloma; NHL = Non-Hodgkin's lymphoma; NMSC = non-melanoma skin cancer; PAH = polycyclic aromatic hydrocarbon; STS = soft tissue sarcoma; TCDD = 2,3,7,8-Tetrachlorodibenzodioxin; UV = ultra violet

Table 4 Total deaths by carcinogenic agent or occupational circumstance and cancer site

Agent	Cancer Site												
	Bladder	Bone	Brain	Breast	Cervix	Kidney	Larynx	Leukaemia	Liver	Lung	LH	Melanoma eye	Mesothelioma
1,3-Butadiene								0			0		
Acrylamide													
Aromatic amines	31												
Arsenic										113			
Asbestos							3			1937			1937
Benzene								4					
Beryllium										6			
Cadmium										8			
Chromium VI										58			
Cobalt										63			
Diesel engine exhaust	47									605			
Ethylene oxide								0					
ETS										249			
Flight personnel				4									
Formaldehyde								6					
Hairdressers and barbers	8												
Inorganic lead			2							36			
Ionising radiation		0						0	0	2			
Leather Dust													
Mineral oils	131									410			
Nickel										8			
Non-arsenical insecticides			9					12					
PAHs	3									1			
PAHs - Coal tars and pitches													
Painters	31									246			

Agent	Cancer Site												
	Bladder	Bone	Brain	Breast	Cervix	Kidney	Larynx	Leukaemia	Liver	Lung	LH	Melanoma eye	Mesothelioma
Petroleum refining			0										
Radon										184			
Rubber industry							1						
Shift work				552									
Silica										789			
Solar radiation													
Soots													
Steel foundry workers										25			
Strong inorganic-acid mists containing sulphuric acid							16			67			
TCDD										187			
Tetrachloroethylene					7								
Tin miners										1			
Trichloroethylene						1			2				
UV												1	
Vinyl chloride									3				
Welders										152			
Wood dust													
Total deaths	245	0	11	555	7	1	20	23	5	4745	0	1	1,937
Total deaths in GB 2005^b	4642	233	3215	12182	1036	3499	766	3102	2794	32798	8479	83	2040

LH= Lymphohaematopoietic; PAH = polycyclic aromatic hydrocarbon; TCDD = 2,3,7,8-Tetrachlorodibenzodioxin; UV = ultra violet

^aBlank cells indicate that attributable cancer deaths were not estimated for this occupational exposure. Zero represents an estimate of less than 0.5.

^bDeaths aged 25+ for solid tumours, aged 15-84 for haematopoietic neoplasms for men and 15-79 for haematopoietic neoplasms for women

Table 4: Continued: deaths by carcinogenic agent or occupational circumstance and cancer site

Agent	MM	Nasopharynx	NHL	NMSC	Oesophagus	Ovary	Pancreas	Sinonasal	NMSC	STS	Stomach	Thyroid	Total across all cancer sites	Rank
1,3-Butadiene													1	40
Acrylamide							1						1	38
Aromatic amines													31	20
Arsenic													113	12
Asbestos											32		3909	1
Benzene													4	30
Beryllium													6	28
Cadmium													8	25
Chromium VI								7					65	14
Cobalt													63	15
Diesel engine exhaust													652	3
Ethylene oxide													0	41
ETS													249	7
Flight personnel													4	34
Formaldehyde			0					0					7	27
Hairdressers and barbers				5		23							36	19
Inorganic lead											16		53	17
Ionising radiation												0	3	36
Leather Dust								10					10	24
Mineral oils				7				16	7				563	4
Nickel								0					8	26
Non-arsenical insecticides	6		13										40	18
PAHs													4	32
PAHs - Coal tars and pitches				4					4				4	33
Painters											57		334	6

Agent	MM	Nasopharynx	NHL	NMSC	Oesophagus	Ovary	Pancreas	Sinonasal	NMSC	STS	Stomach	Thyroid	Total across all cancer sites	Rank
Petroleum refining													0	42
Radon													184	9
Rubber industry											4		5	29
Shift work													552	5
Silica													789	2
Solar radiation				12					12				12	23
Soots					59								59	16
Steel foundry workers													25	21
Strong inorganic-acid mists containing sulphuric acid													83	13
TCDD			31							13			231	8
Tetrachloroethylene			7		126								140	11
Tin miners													1	39
Trichloroethylene			1										4	31
UV													1	37
Vinyl chloride													3	35
Welders													152	10
Wood dust			7					11					19	22
Total deaths	6	8	57	23	184	23	1	38	23	13	108	0	8010	
Total deaths in GB in 2005^b	1769	97	3281	501	7286	4234	7111	115	501	557	5515	337	150124^c	

MM = multiple myeloma; NHL = Non-Hodgkin's lymphoma; NMSC = non-melanoma skin cancer; PAH = polycyclic aromatic hydrocarbon; STS = soft tissue sarcoma; TCDD = 2,3,7,8-Tetrachlorodibenzodioxin; UV = ultra violet

^aBlank cells indicate that attributable cancer deaths were not estimated for this occupational exposure. Zero represents an estimate of less than 0.5.

^bDeaths aged 25+ for solid tumours, aged 15-84 for haematopoietic neoplasms for men and 15-79 for haematopoietic neoplasms for women

^cAll malignant neoplasms

Table 5 Total cancer registrations by carcinogenic agent or occupational circumstance and cancer site

Agent	Bladder	Bone	Brain	Breast	Cervix	Kidney	Larynx	Leukaemia	Liver	Lung	LH	Melanoma eye	Mesothelioma
1,3-Butadiene								0			1		
Acrylamide													
Aromatic amines	66												
Arsenic										129			
Asbestos							8			2223			1937
Benzene								7					
Beryllium										7			
Cadmium										9			
Chromium VI										67			
Cobalt										73			
Diesel engine exhaust	106									695			
Ethylene oxide								1					
ETS										284			
Flight personnel				13									
Formaldehyde								10					
Hairdressers and barbers	15												
Inorganic lead			2							41			
Ionising radiation		0						1	0	2			
Leather Dust													
Mineral oils	296									470			
Nickel										9			
Non-arsenical insecticides			11					19					
PAHs	7									1			
PAHs - Coal tars and pitches													
Painters	71									282			
Petroleum refining			0										

Agent	Bladder	Bone	Brain	Breast	Cervix	Kidney	Larynx	Leukaemia	Liver	Lung	LH	Melanoma eye	Mesothelioma
Radon										209			
Rubber industry							3						
Shift work				1957									
Silica										907			
Solar radiation													
Soots													
Steel foundry workers										29			
Strong inorganic-acid mists containing sulphuric acid							46			76			
TCDD										215			
Tetrachloroethylene					18								
Tin miners										1			
Trichloroethylene						3			2				
UV												6	
Vinyl chloride									3				
Welders										175			
Wood dust													
Total Attributable Registrations	550	0	14	1969	18	3	56	38	5	5442	1	6	1937
Total Registrations in GB, 2004	9878	323	3933	43202	2612	6759	2112	5147	2798	37378	18090	383	2040

LH = lymphohaematopoietic cancers; PAH = polycyclic aromatic hydrocarbon; TCDD = 2,3,7,8-Tetrachlorodibenzodioxin; UV = ultra violet

^aBlank cells indicate that attributable cancer registrations were not estimated for this occupational exposure. Zero represents an estimate of less than 0.5.

^bRegistrations aged 25+ for solid tumours, aged 15-84 for haematopoietic neoplasms for men and 15-79 for haematopoietic neoplasms for women; figures for mesothelioma based on deaths.

Table 5: Continued: total cancer registrations by carcinogenic agent or occupational circumstance and cancer site

Agent	MM	Nasopharynx	NHL	NMSC	Oesophagus	Ovary	Pancreas	Sinonasal	STS	Stomach	Thyroid	Total across all cancer sites	Rank
1,3-Butadiene												1	38
Acrylamide							1					1	39
Aromatic amines												66	19
Arsenic												129	14
Asbestos										47		4216	1
Benzene												7	34
Beryllium												7	32
Cadmium												9	28
Chromium VI								22				89	16
Cobalt												73	18
Diesel engine exhaust												801	6
Ethylene oxide												1	41
ETS												284	10
Flight personnel												13	26
Formaldehyde		1						1				12	27
Hairdressers and barbers			14			33						63	21
Inorganic lead										23		65	20
Ionising radiation											1	4	36
Leather Dust								31				31	24
Mineral oils				902				55				1722	3
Nickel								0				9	30
Non-arsenical insecticides	10		33									73	17
PAHs												8	31
PAHs - Coal tars and pitches				475								475	7
Painters										83		437	8
Petroleum refining												0	42

Agent	MM	Nasopharynx	NHL	NMSC	Oesophagus	Ovary	Pancreas	Sinonasal	STS	Stomach	Thyroid	Total across all cancer sites	Rank
Radon												209	11
Rubber industry										6		9	29
Shift work												1957	2
Silica												907	5
Solar radiation				1541								1541	4
Soots					60							60	22
Steel foundry workers												29	25
Strong inorganic-acid mists containing sulphuric acid												122	15
TCDD			74						27			316	9
Tetrachloroethylene			17		130							164	13
Tin miners												1	40
Trichloroethylene			3									7	33
UV												6	35
Vinyl chloride												3	37
Welders												175	12
Wood dust		14						39				54	23
Total Attributable Registrations	10	15	140	2,862	188	33	1	126	27	157	1	13598	
Total Registrations in GB 2004^b	3006	189	8236	67220	7498	6197	7246	378	1063	7970	1519	343583^c	

MM = multiple myeloma; NHL = Non-Hodgkin's lymphoma; NMSC = non-melanoma skin cancer; PAH = polycyclic aromatic hydrocarbon; STS = soft tissue sarcoma; TCDD = 2,3,7,8-Tetrachlorodibenzodioxin; UV = ultra violet

^aBlank cells indicate that attributable cancer registrations were not estimated for this occupational exposure. Zero represents an estimate of less than 0.5.

^bRegistrations aged 25+ for solid tumours, aged 15-84 for haematopoietic neoplasms for men and 15-79 for haematopoietic neoplasms for women; figures for mesothelioma based on deaths.

^cAll malignant neoplasms

3.3 DEATHS AND REGISTRATIONS BY INDUSTRY SECTOR AND CARCINOGENIC AGENT OR OCCUPATIONAL CIRCUMSTANCE

Tables 6a,b, 7 and 8 give numbers ever exposed over the risk exposure period (REP), total deaths and total registrations respectively, by industry sector and for each carcinogenic agent or occupational circumstance; a rank based on the total over all carcinogenic agents is given for industry sector. Numbers of deaths and registrations for males, females and the total are available on the HSE website, together with the respective attributable fractions. Based on CAREX data very large numbers are estimated to have been exposed to carcinogens in the construction sector, 2 million to RCS, 1.6 million to solar radiation through outdoor work and nearly 500,000 to diesel engine exhaust (DEE). LFS 1979 data also highlighted the large numbers employed as painters in the construction sector as well as roofers, road builders and paviors who were exposed to coal tars and pitches. In the services sector the highest numbers (over 1 million during the REP) were estimated to have been occupationally exposed to benzene and mineral oils, mainly in personal and household services (including vehicle repair and other repair services), and to diesel engine exhaust mainly in land transport. About 2.3 million service sector workers have been exposed to a risk of NMSC from outdoor work in the sun, 1.8 million are at risk of lung cancer from past exposure to radon and 1.5 million non-smokers are at risk of lung cancer from environmental tobacco smoke (ETS) in the workplace. Very large numbers of women (nearly 2 million) have worked as night shift workers (breast cancer) in occupations associated with health-care, transport, communication, leisure and hospitality sectors, and air transport. About 1.7 million have been exposed to non-arsenical pesticides and dioxins in agriculture, forestry and fishing, and nearly 500,000 to solar radiation. Also amongst the largest numbers exposed are to mineral oils including 4.2 million metal workers, and 1.2 million welders (both estimated from LFS data). The exposure pattern for many of the carcinogens relevant to the short latency cancers (leukaemia, lymphoma etc; REP 1996-2005) is different to that of the long latency cancers with the largest numbers of those ever exposed being in the service industry sectors, followed by manufacturing, agriculture and a relatively small number in construction (Table 6b).

The top ten industry sectors contributing to the total burden differ between deaths and registrations, being for deaths (Table 7): construction, shift work, personal and household services (this sector includes repair trades, laundries and dry cleaning, domestic services, hairdressing and beauty), land transport, metal workers, painters and decorators in the construction industry, printing and publishing, mining, wholesale and retail trades, and manufacture of transport equipment; and for registrations (Table 8): construction, shift work, metal work, personal and household services, land transport, roofers and road repairs, painters and decorators in the construction industry, mining, printing and publishing, and public administration and defence. The difference occurs because of the increased numbers of cancer registrations compared to deaths for longer survival cancers such as breast and NMSC.

Twenty one industry sectors have 100 or more total attributable registrations (Table 8). As can be seen from examination of the columns in both tables 7 and 8, the majority of industry sectors involve exposure to several carcinogens (many over 10) with construction and many of the manufacturing sectors involving potential exposure to between 15 and 20 carcinogens. In addition, the potential occurrence of several exposures in what might be thought as less traditionally exposed sectors e.g. dry cleaning, hairdressing and beauty is highlighted. There are several key exposures which give rise to substantial numbers of registrations across multiple industry sectors. Of note is the contribution of exposure to (i) asbestos, DEE, silica and solar radiation in the construction industry; (ii) asbestos, DEE, ETS (non-smokers), soots

and tetrachloroethylene in personal and household services; (iii) asbestos and DEE in land transport (railway, road, pipeline); (iv) asbestos, DEE, silica and solar radiation in mining; (v) ETS (non-smokers) and solar radiation in public administration and defence; (vi) asbestos, ETS (non-smokers) and radon in the wholesale and retail trade, restaurants and hotels and (vii) dioxins, non-arsenical insecticides and solar radiation in farming.

Table 6a Total numbers ever exposed over the risk exposure period by industry sector and carcinogenic agent or occupational circumstance: Long latency cancers

Industry Sector/Carcinogenic agent	Acrylamide	Aromatic amines	Arsenic	Asbestos	Beryllium	Cadmium	Chromium VI	Cobalt	Diesel engine exhaust	Environmental Tobacco Smoke	Flight personnel ⁽²⁾
Farming										7,049	
Forestry										487	
Horticulture											
Total agricultural, hunting, fishing and forestry										7,536	
Beverage industries							1,504	182	26,540		
Crude petroleum and natural gas production					968		6,823	268	42,885		
Electricity, gas and steam			1,731	1,470	695	3,542	3,759	831	21,613	26,068	
Food manufacturing	68						11,669	12,666	21,983	17,024	
General industry											
Iron and steel basic industries ⁽¹⁾		40,761					3,873		5,450	9,451	
Manufacture of electrical machinery, apparatus, appliances and supplies	46		8,258		3,958	6,971	30,999	2,096	6,971	48,664	
Manufacture of fabricated metal products, except machinery and equipment					3,337	13,668	119,816	35,982	22,325	36,021	
Manufacture of footwear						125	615				
Manufacture of furniture and fixture, except primary of metal			8,674				786	25,156	2,870		
Manufacture of glass and glass products			7,313		1,669	2,574	3,468	2,905	598	5,332	
Manufacture of industrial chemicals	4,340	74	4,585	4,866	171	6,396	17,199	6,572	9,038	13,345	
Manufacture of instruments, photographic and optical goods					1,344	7,096	9,403	5,820	877	26,550	
Manufacture of leather and products of leather or of its substitutes		17,682					3,155	46			
Manufacture of machinery except electrical					46,490	13,253	129,805	17,701	17,974	127,967	
Manufacture of miscellaneous products of petroleum and coal									222		
Manufacture of other chemical products	1,247		285	5,210		80	9,260	10,650	7,899	21,608	
Manufacture of other non-metallic mineral products			1,264			5,969	962	154	66,138		
Manufacture of paper and paper products				2,791			10,263	2,113	6,515	8,740	

Industry Sector/Carcinogenic agent	Acrylamide	Aromatic amines	Arsenic	Asbestos	Beryllium	Cadmium	Chromium VI	Cobalt	Diesel engine exhaust	Environmental Tobacco Smoke	Flight personnel⁽²⁾
Manufacture of plastic products not elsewhere classified		1,150				17,729	19,409	2,358	1,669	7,337	
Manufacture of pottery, china and earthenware						2,700	1,424	2,700		25,318	
Manufacture of rubber products	626	1,259			23	2,842	5,285	148		6,710	
Manufacture of textiles		66,587			103	3,178	18,714	831	5,746	11,235	
Manufacture of transport equipment			120	8,668	2,654	4,135	82,478	13,247	14,659	115,452	
Manufacture of wearing apparel, except footwear						40	5,764	3,326	6,379	23,354	
Manufacture of wood and wood and cork products, except furniture			36,649			159	17,199	7,620	22,872	2,732	
Metal Workers											
Mining				69,088					72,254		
Non-ferrous metal basic industries			52,834			34,023	13,486	6,248	15,109		
Other manufacturing industries		103	302			6,720	3,531	1,333	1,857	10,977	
Painters (not construction)											
Petroleum refineries			251	2,844		1,048	4,978	74	4,704	5,193	
Printing, publishing and allied industries						8,708	20,696	14,306	3,389	65,568	
Tobacco manufacture									68		
Water works and supply									23,322		
Welders											
Total manufacturing industry, mining, quarrying, electricity, gas, water	6,327	127,615	122,265	94,937	61,411	140,956	556,324	175,332	431,929	614,646	
Construction			12,786	209,244		27,671	19,333	12,237	483,589	123,609	
Painters and decorators (construction)											
Roofers, road surfacers, Roadmen, Paviers (Construction)											
Total Construction			12,786	209,244		27,671	19,333	12,237	483,589	123,609	
Air transport					911	3,263	17,831	5,208	27,901	68,310	
Business, professional and other organisation										4,718	
Communication									25,861	41,707	
Education services	7,502	3,829								24,732	
Financing, insurance, real estate and business services										202,885	

Industry Sector/Carcinogenic agent	Acrylamide	Aromatic amines	Arsenic	Asbestos	Beryllium	Cadmium	Chromium VI	Cobalt	Diesel engine exhaust	Environmental Tobacco Smoke	Flight personnel ⁽²⁾
Flight Personnel											13,902
Land transport				10,002			6,295		615,665	18,311	
Medical, dental, other health and veterinary services	62	1,492								30,127	
Personal and household services		52,872		97,038		13,637	85,230		284,099	132,655	
Public administration and defence									10,316	121,847	
Recreational and cultural services			163							54,516	
Research and scientific institutes	1,548	10,016								6,193	
Sanitary and similar services			1,635	3,624		3,053	1,846	194	17,423	18,643	
Services allied to transport						1,244	305	948	57,390	36,860	
Shift work											
Water transport							4,227		53,531	23,168	
Welfare institutions										31,358	
Wholesale and retail trade and restaurants and hotels				17,793					55,566	720,607	
Total Service industries	9,112	68,208	1,798	128,457	911	21,197	115,735	6,349	1,147,754	1,536,637	13,902
TOTAL	15,439	195,824	136,849	432,638	62,322	189,825	691,392	193,919	2,063,271	2,282,428	13,902

⁽¹⁾ Iron and steel basic industries have been excluded when estimating lung cancer burden due to exposure to Chromium VI and Diesel engine exhaust to avoid overlap with the separate estimate for steel foundry workers; iron and steel basic industries have been included when estimating burden for sinonasal cancer due to Chromium VI exposure and bladder cancer due to Diesel engine exhaust exposure.

⁽²⁾ For flight personnel as an exposure (breast cancer only), flight personnel are women identified in the BA Stewards and Stewardesses Union (BASSA) data cohort only

Table 6a continued Total numbers ever exposed over the risk exposure period by industry sector and carcinogenic agent or occupational circumstance: Long latency cancers

Industry Sector/Carcinogenic Agent	Formaldehyde	Hairdressers and barbers	Inorganic lead	Ionising radiation⁽²⁾	Leather Dust	Mineral oils⁽³⁾	Nickel⁽⁴⁾	Non-arsenical insecticides	Polycyclic Aromatic Hydrocarbons	PAHs - Coal tars and pitches	Painters
Farming								1,268,835			
Forestry								31,128			
Horticulture								383,354			
Total agricultural, hunting, fishing and forestry								1,683,317			
Beverage industries	5,017		581								
Crude petroleum and natural gas production	3,736		16,328						5,057		
Electricity, gas and steam			15,286	154,014			3,468		28,453		
Food manufacturing			3,229				7,740	42,308	5,524		
General industry				40,969							
Iron and steel basic industries ⁽¹⁾	10,650		21,152			129,417			27,981	2,771	
Manufacture of electrical machinery, apparatus, appliances and supplies			44,309				5,467				
Manufacture of fabricated metal products, except machinery and equipment	3,047		76,623			47,300	157,734		34,786		
Manufacture of footwear					426,118				740		
Manufacture of furniture and fixture, except primary of metal	226,509										
Manufacture of glass and glass products	1,583		19,802				2,688		4,659		
Manufacture of industrial chemicals	5,729		10,001				8,019	7,317	5,729		
Manufacture of instruments, photographic and optical goods			19,398			448,391	2,984				
Manufacture of leather and products of leather or of its substitutes			23		174,829				1,219		
Manufacture of machinery except electrical	4,328		136,941	14,301		39,754	142,898		23,384		
Manufacture of miscellaneous products of petroleum and coal			495						467		
Manufacture of other chemical products	2,050		15,457				177				
Manufacture of other non-metallic mineral products	3,332		11,402						11,806		
Manufacture of paper and paper products	4,112		2,335				6,413		1,646		

Industry Sector/Carcinogenic Agent	Formaldehyde	Hairdressers and barbers	Inorganic lead	Ionising radiation⁽²⁾	Leather Dust	Mineral oils⁽³⁾	Nickel⁽⁴⁾	Non-arsenical insecticides	Polycyclic Aromatic Hydrocarbons	PAHs - Coal tars and pitches	Painters
Manufacture of plastic products not elsewhere classified	11,510		43,204								
Manufacture of pottery, china and earthenware			53,934				1,521		7,757		
Manufacture of rubber products			4,767						21,915		
Manufacture of textiles	26,938		962								
Manufacture of transport equipment			85,906			15,475	73,474		52,920		
Manufacture of wearing apparel, except footwear	102,468		2,785						48,090		
Manufacture of wood and wood and cork products, except furniture	70,791		4,886						2,933		
Metal Workers						4,243,912					
Mining			442	1,445			1,900		1,571		
Non-ferrous metal basic industries	7,142		35,310				53,631		9,260		
Other manufacturing industries			7,899				1,378				
Painters (not construction)											327,246
Petroleum refineries			1,196						3,053		
Printing, publishing and allied industries			5,969			451,226	74		598		
Tobacco manufacture			68						581		
Water works and supply			21,830								
Welders											
Total manufacturing industry, mining, quarrying, electricity, gas, water	488,944		662,520	210,730	600,947	5,375,475	469,566	49,626	300,130	2,771	327,246
Construction	20,453		123,951				2,031		20,453		
Painters and decorators (construction)											922,197
Roofers, road surfacers, Roadmen, Paviers (Construction)										343,695	
Total Construction	20,453		123,951				2,031		20,453	343,695	922,197
Air transport			9,970				70				
Business, professional and other organisation											
Communication			35,045								
Education services	528										
Financing, insurance, real estate and business services											
Flight Personnel				69,973							

Industry Sector/Carcinogenic Agent	Formaldehyde	Hairdressers and barbers	Inorganic lead	Ionising radiation ⁽²⁾	Leather Dust	Mineral oils ⁽³⁾	Nickel ⁽⁴⁾	Non-arsenical insecticides	Polycyclic Aromatic Hydrocarbons	PAHs - Coal tars and pitches	Painters
Land transport			7,535	735					38,514		
Medical, dental, other health and veterinary services	12,095			1,683							
Personal and household services	1,100	727,978	328,422			1,011,308			100,005		
Public administration and defence			1,030						1,030		
Recreational and cultural services	320										
Research and scientific institutes	761			1,763							
Sanitary and similar services			2,917	6,571					38,901		
Services allied to transport			3,111				99		2,851		
Shift work											
Water transport			7,581						705		
Welfare institutions											
Wholesale and retail trade and restaurants and hotels			40,005						20,003		
Total Service industries	14,804	727,978	435,616	80,725		1,011,308	169		202,008		
TOTAL	524,201	727,978	1,222,087	291,455	600,947	6,386,783	471,766	1,732,942	522,591	346,466	1,249,443

⁽¹⁾ Iron and steel basic industries have been excluded when estimating lung cancer burden due to exposure to inorganic lead and polycyclic aromatic hydrocarbons to avoid overlap with the separate estimate for steel foundry workers; iron and steel basic industries have been included when estimating burden for bladder cancer due to exposure to polycyclic aromatic hydrocarbons and for liver cancer and stomach cancer due to exposure to inorganic lead.

⁽²⁾ For Ionising Radiation exposure data were obtained from the Central Index of Dose Information (CIDI, 1998) which excludes air crew, plus data from the LFS for male flight crew and from a cohort of women flight crew from the BA Stewards and Stewardesses Union (BASSA) data.

⁽³⁾ For mineral oils different paths of exposure were recognised (dermal and inhalation), and therefore some industries were excluded from the estimates for the different cancer sites. Non-melanoma skin cancer included only dermal exposure; lung, bladder and sinonasal cancers exclude solely dermal exposure (motor mechanics (personal and household services), office machinery mechanics (manufacture of machinery except electrical) and aircraft engine maintenance fitters (manufacture of transport equipment)). Printers were included (with a high level relative risk) in the estimates for lung cancer, but excluded for the other cancer sites. The total given here includes all these exposed groups.

⁽⁴⁾ For lung cancer from nickel exposure the number shown here for non-ferrous metals basic industries is from CAREX. For sinonasal cancer for which only high level exposure was considered to have excess risk, numbers for the Clydach cohort only were used (not shown in this table).

Table 6a continued: Total numbers ever exposed over the risk exposure period by industry sector and carcinogenic agent or occupational circumstance: Long latency cancers

Industry Sector/Carcinogenic Agent	Petroleum refining	Radon	Rubber industry	Shift work	Silica	Solar radiation	Soots	Steel foundry workers	Strong inorganic-acid mists with sulphuric acid
Farming		5,653				470,020			
Forestry		109				27,650			
Horticulture									
<i>Total agricultural, hunting, fishing and forestry</i>		5,763				497,669			
Beverage industries		15,052			137				
Crude petroleum and natural gas production					9,511				8,394
Electricity, gas and steam		18,555			19,261	104,393			
Food manufacturing		67,927			2,050	47,202			
General industry									
Iron and steel basic industries ⁽¹⁾		7,353				11,032		57,538	13,968
Manufacture of electrical machinery, apparatus, appliances and supplies		79,334							27,995
Manufacture of fabricated metal products, except machinery and equipment		45,920			45,573	49,941			32,319
Manufacture of footwear		6,624			570				
Manufacture of furniture and fixture, except primary of metal		23,681			2,267				
Manufacture of glass and glass products		5,849			39,479	36,928			
Manufacture of industrial chemicals		19,990			3,520				30,462
Manufacture of instruments, photographic and optical goods		14,688			8,924				
Manufacture of leather and products of leather or of its substitutes		2,893			900				4,464
Manufacture of machinery except electrical		105,310			92,564				23,437
Manufacture of miscellaneous products of petroleum and coal		188			1,652				
Manufacture of other chemical products		28,111			32,246				36,419
Manufacture of other non-metallic mineral products		9,557			138,997	60,557			
Manufacture of paper and paper products		18,105							17,587
Manufacture of plastic products not elsewhere classified		21,289			9,967				
Manufacture of pottery, china and earthenware		7,278			123,979	46,382			82
Manufacture of rubber products		9,061	208,326		4,004				

Industry Sector/Carcinogenic Agent	Petroleum refining	Radon	Rubber industry	Shift work	Silica	Solar radiation	Soots	Steel foundry workers	Strong inorganic-acid mists with sulphuric acid
Manufacture of textiles		31,153			1,925				
Manufacture of transport equipment		61,838			36,563	312,256			21,675
Manufacture of wearing apparel, except footwear		31,432			2,813	32,377			
Manufacture of wood and wood and cork products, except furniture		17,934				98,453			
Metal Workers									
Mining		947			85,414	57,258			
Non-ferrous metal basic industries		12,085			13,703	18,071			25,217
Other manufacturing industries		10,143			7,495				
Painters (not construction)									
Petroleum refineries	139,905	2,176			649	14,397			
Printing, publishing and allied industries		51,507			4,306	181,802			
Tobacco manufacture		1,714			6				
Water works and supply		3,132				51,456			
Welders									
Total manufacturing industry, mining, quarrying, electricity, gas, water	139,905	730,827	208,326		688,473	1,122,505		57,538	228,051
Construction					2,039,989				
		95,736				1,575,241			
Painters and decorators (construction)									
Roofers, road surfacers, Roadmen, Paviers (Construction)									
Total Construction					2,039,989				
		95,736				1,575,241			
Air transport		10,305			2,892				4,660
Business, professional and other organisation		14,646				61,412			
Communication		34,523				289,061			
Education services		177,151			2,513				
Financing, insurance, real estate and business services		337,980				216,118			
Flight Personnel									
Land transport		49,480			21,107	363,730			
Medical, dental, other health and veterinary services		181,039				38,252			
Personal and household services		80,702				28,447	84,585		
Public administration and defence		158,512				449,292			

Industry Sector/Carcinogenic Agent	Petroleum refining	Radon	Rubber industry	Shift work	Silica	Solar radiation	Soots	Steel foundry workers	Strong inorganic-acid mists with sulphuric acid
Recreational and cultural services		55,379				115,359			
Research and scientific institutes		9,912			3,626	31,450			
Sanitary and similar services		25,910			15,491	142,019			
Services allied to transport		14,987			2,423	163,769			
Shift work				1,953,645					
Water transport		7,069			4,915	38,252			
Welfare institutions		74,319				16,083			
Wholesale and retail trade and restaurants and hotels		537,416				368,313			
Total Service industries		1,769,331		1,953,645	52,967	2,321,557	84,585		4,660
TOTAL	139,905	2,601,656	208,326	1,953,645	2,781,429	5,516,973	84,585	57,538	246,679

⁽¹⁾ Iron and steel basic industries have been excluded when estimating lung cancer burden due to exposure to strong inorganic acid mists to avoid overlap with the separate estimate for steel foundry workers; iron and steel basic industries have been included when estimating burden for laryngeal cancer due to exposure to strong inorganic acid mists.

Table 6a continued Total numbers ever exposed over the risk exposure period by industry sector and carcinogenic agent or occupational circumstance: Long latency cancers

Industry Sector/Carcinogenic Agent	TCDD (Dioxins) ⁽¹⁾	Tetrachloroethylene	Tin miners ⁽²⁾	Trichloroethylene	Ultra Violet	Vinyl chloride	Welders	Wood dust
Farming	1,268,835							
Forestry	31,128							30,567
Horticulture	383,354							
<i>Total agricultural, hunting, fishing and forestry</i>	1,683,317							30,567
Beverage industries		1,999		524				51
Crude petroleum and natural gas production		353						387
Electricity, gas and steam		18,071						137
Food manufacturing		12,734				23		2,346
General industry								
Iron and steel basic industries	240,104	5,365						1,071
Manufacture of electrical machinery, apparatus, appliances and supplies		18,441		10,548				3,896
Manufacture of fabricated metal products, except machinery and equipment		34,183		12,182				11,983
Manufacture of footwear								63
Manufacture of furniture and fixture, except primary of metal								536,465
Manufacture of glass and glass products	228,021	1,310		740				1,173
Manufacture of industrial chemicals	56,972					7,540		3,531
Manufacture of instruments, photographic and optical goods						11		752
Manufacture of leather and products of leather or of its substitutes		649		46				182
Manufacture of machinery except electrical		48,785		17,319				28,129
Manufacture of miscellaneous products of petroleum and coal								
Manufacture of other chemical products						7,905		6,555
Manufacture of other non-metallic mineral products	104,644			285		11		8,531
Manufacture of paper and paper products	170,219	12,564						24,535
Manufacture of plastic products not elsewhere classified						5,752		2,364

Industry Sector/Carcinogenic Agent	TCDD (Dioxins)⁽¹⁾	Tetrachloroethylene	Tin miners⁽²⁾	Trichloroethylene	Ultra Violet	Vinyl chloride	Welders	Wood dust
Manufacture of pottery, china and earthenware	207,797	171						
Manufacture of rubber products								142
Manufacture of textiles		18,122						330
Manufacture of transport equipment		14,956		16,795				41,415
Manufacture of wearing apparel, except footwear		23,504		666		46		285
Manufacture of wood and wood and cork products, except furniture	91,435							318,532
Metal Workers								
Mining			416					
Non-ferrous metal basic industries	300,498	3,844				188		1,481
Other manufacturing industries								11,123
Painters (not construction)								
Petroleum refineries		23				439		137
Printing, publishing and allied industries		16,095						12,108
Tobacco manufacture		137		228				40
Water works and supply		1,891						
Welders					626,978		626,978	
Total manufacturing industry, mining, quarrying, electricity, gas, water	1,399,690	233,196	416	59,333	626,978	21,915	626,978	1,017,743
Construction		68,396						1,034,277
Painters and decorators (construction)								
Roofers, road surfacers, Roadmen, Paviers (Construction)								
Total Construction		68,396						1,034,277
Air transport		5,459				9		2,299
Business, professional and other organisation								
Communication		1,401						29
Education services		251		553		539		10,045
Financing, insurance, real estate and business services								
Flight Personnel								
Land transport		24,596						21,070
Medical, dental, other health and veterinary services								
Personal and household services		227,280		24,999				
Public administration and defence								

Industry Sector/Carcinogenic Agent	TCDD (Dioxins)⁽¹⁾	Tetrachloroethylene	Tin miners⁽²⁾	Trichloroethylene	Ultra Violet	Vinyl chloride	Welders	Wood dust
Recreational and cultural services				335				
Research and scientific institutes		363		399		389		
Sanitary and similar services				530				17,098
Services allied to transport		1,335				795		15,677
Shift work								
Water transport		705				261		239
Welfare institutions								
Wholesale and retail trade and restaurants and hotels	41,007							
Total Service industries	41,007	261,389		26,816		1,993		66,456

⁽¹⁾ For TCDD (long latency) the estimates for lung cancer from LFS 1979 data include farming, forestry and horticulture

⁽²⁾ For tin miners the number shown here was for the whole cohort employed from 1941, not a point estimate.

Table 6b Total numbers ever exposed over the risk exposure period by industry sector and carcinogenic agent or occupational circumstance: Short latency cancers

Industry Sector/Carcinogenic Agent	1,3-Butadiene	Benzene	Ethylene oxide	Formaldehyde	Ionising radiation⁽¹⁾	Non-arsenical insecticides	TCDD (Dioxins)⁽²⁾	Tetrachloroethylene	Trichloroethylene	
Farming						1,053,200	1,259,549			
Forestry						43,904	53,799			
Horticulture						383,402	308,412			
<i>Total agricultural, hunting, fishing and forestry</i>						1,480,506	1,621,760			
Beverage industries		5		2,499				996	261	
Crude petroleum and natural gas production		1,305	907	1,861				176		
Electricity, gas and steam					59,374			9,001		
Food manufacturing			249			20,305		6,343		
General industry					11,912					
Iron and steel basic industries		1,937		5,305			431,232	2,672		
Manufacture of electrical machinery, apparatus, appliances and supplies								9,185	5,254	
Manufacture of fabricated metal products, except machinery and equipment				1,518				17,026	6,068	
Manufacture of footwear										
Manufacture of furniture and fixture, except primary of metal				112,820						
Manufacture of glass and glass products				789			153,873	652	369	
Manufacture of industrial chemicals	2,110	3,170		2,854		7,444	25,819			
Manufacture of instruments, photographic and optical goods										
Manufacture of leather and products of leather or of its substitutes								323	23	
Manufacture of machinery except electrical				2,156	4,410			24,299	8,626	
Manufacture of miscellaneous products of petroleum and coal		113								
Manufacture of other chemical products	721	4,301	1,387	1,021						
Manufacture of other non-metallic mineral products				1,659			52,602		142	
Manufacture of paper and paper products	6			2,048			150,697	6,258		
Manufacture of plastic products not elsewhere classified	3,438	3,895		5,733						

Industry Sector/Carcinogenic Agent	1,3-Butadiene	Benzene	Ethylene oxide	Formaldehyde	Ionising radiation⁽¹⁾	Non-arsenical insecticides	TCDD (Dioxins)⁽²⁾	Tetrachloroethylene	Trichloroethylene	
Manufacture of pottery, china and earthenware							130,361	85		
Manufacture of rubber products	902									
Manufacture of textiles				13,417				9,026		
Manufacture of transport equipment								7,449	8,365	
Manufacture of wearing apparel, except footwear				51,037				11,707	332	
Manufacture of wood and wood and cork products, except furniture				35,260			23,613			
Metal Workers										
Mining					694					
Non-ferrous metal basic industries		36		3,557			125,164	1,915		
Other manufacturing industries										
Painters (not construction)										
Petroleum refineries	335	1,277						11		
Printing, publishing and allied industries								8,016		
Tobacco manufacture								68	113	
Water works and supply								942		
Welders										
Total manufacturing industry, mining, quarrying, electricity, gas, water	7,511	16,039	2,543	243,533	76,390	27,748	1,093,362	116,150	29,552	
Construction				14,297				47,808		
Painters and decorators (construction)										
Roofers, road surfacers, Roadmen, Paviers (Construction)										
Total Construction				14,297				47,808		
Air transport		227						4,354		
Business, professional and other organisation										
Communication								1,117		
Education services	423	4,319	423	423				200	446	
Financing, insurance, real estate and business services										
Flight Personnel					103,400					
Land transport		25,722			291			19,616		
Medical, dental, other health and veterinary services	45		6,467	9,701	424					
Personal and household services		811,110		874				181,263	20,155	

Industry Sector/Carcinogenic Agent	1,3-Butadiene	Benzene	Ethylene oxide	Formaldehyde	Ionising radiation⁽¹⁾	Non-arsenical insecticides	TCDD (Dioxins)⁽²⁾	Tetrachloroethylene	Trichloroethylene	
Public administration and defence										
Recreational and cultural services				257					270	
Research and scientific institutes	305	1,559	305	611	1,295			289	321	
Sanitary and similar services		2,625			2,650				427	
Services allied to transport		28						1,065		
Shift work										
Water transport		2,073						562		
Welfare institutions										
Wholesale and retail trade and restaurants and hotels		183,009					18,375			
Total Service industries	774	1,030,671	7,196	11,865	108,059		18,375	208,467	21,619	
TOTAL	8,285	1,046,710	9,739	269,695	184,449	1,508,254	2,733,496	372,425	51,172	

⁽¹⁾ For Ionising Radiation exposure data were obtained from the Central Index of Dose Information (CIDI, 1998) which excludes air crew, plus data from the LFS for male flight crew and from a cohort of women flight crew from the BA Stewards and Stewardesses Union (BASSA) data.

⁽²⁾ For TCDD (short latency) the estimates for Soft tissue sarcoma from Census of Employment data are used which include farming, forestry and horticulture; (excluded for Non-Hodkin's Lymphoma). The total given here includes all exposed industries.

Table 7 Total cancer deaths by industry sector and carcinogenic agent or occupational circumstance

Industry Sector/Carcinogenic agent	1,3-Butadiene	Acrylamide	Aromatic amines	Arsenic	Asbestos ¹	Benzene	Beryllium	Cadmium	Chromium VI	Cobalt	Diesel engine exhaust	Ethylene oxide	Environmental Tobacco Smoke	Flight personnel
Farming														
Forestry														
Horticulture														
<i>Total agricultural, hunting, fishing and forestry</i>														
Beverage industries						0			0	0	2			
Crude petroleum and natural gas production						0			0	0	4	0		
Electricity, gas and steam				1	18		0		0	0	2			
Food manufacturing									0	3	2	0		
General industry														
Iron and steel basic industries			7			0			0		0			
Manufacture of electrical machinery, apparatus, appliances and supplies				5			0	1	0	1	1			
Manufacture of fabricated metal products, except machinery and equipment							0		20	9	2			
Manufacture of footwear									0					
Manufacture of furniture and fixture, except primary of metal				7					0	7	0			
Manufacture of glass and glass products				6			0		0	1	0			
Manufacture of industrial chemicals	0	1	0	3	60	0		1	3	5	1			
Manufacture of instruments, photographic and optical goods							0		0	2	0			
Manufacture of leather and products of leather or of its substitutes			3						0	0				
Manufacture of machinery except electrical							5		22	5	2			
Manufacture of miscellaneous products of petroleum and coal						0					0			
Manufacture of other chemical products	0	0		0	64	0			2	9	1	0		
Manufacture of other non-metallic mineral products				1					0	0	6			
Manufacture of paper and paper products	0				34				0	1	1			
Manufacture of plastic products not elsewhere classified	0		0			0			0	1	0			
Manufacture of pottery, china and earthenware									0	1				
Manufacture of rubber products	0	0	0						0	0				
Manufacture of textiles			11						0	0	1			
Manufacture of transport equipment				0	106		0		14	3	1			
Manufacture of wearing apparel, except footwear									0	1	1			

Industry Sector/Carcinogenic agent	1,3-Butadiene	Acrylamide	Aromatic amines	Arsenic	Asbestos ¹	Benzene	Beryllium	Cadmium	Chromium VI	Cobalt	Diesel engine exhaust	Ethylene oxide	Environmental Tobacco Smoke	Flight personnel
Manufacture of wood and wood and cork products, except furniture				31					0	2	2			
Metal Workers														
Mining					167						35			
Non-ferrous metal basic industries				44		0		6	2	5	1			
Other manufacturing industries			0	0					1	0	0			
Painters (not construction)														
Petroleum refineries	0			0	35	0			0	0	0			
Printing, publishing and allied industries									0	4	0			
Tobacco manufacture											0			
Water works and supply											2			
Welders														
Total manufacturing industry, mining, quarrying, electricity, gas, water	0	1	22	99	485	0	6	8	64	58	66	0		
Construction				13	2,568				0	4	234		32	
Painters and decorators (construction)														
Roofers, road surfacers, Roadmen, Paviers (Construction)														
Total Construction				13	2,568				0	4	234		32	
Air transport						0			0	1	2		10	
Business, professional and other organisation													1	
Communication											2		6	
Education services	0		0			0							4	
Financing, insurance, real estate and business services													29	
Flight Personnel														4
Land transport					123	0			0		284		3	
Medical, dental, other health and veterinary services	0		0									0		
Personal and household services			9		326	3			1		25		19	
Public administration and defence											1		18	
Recreational and cultural services				0									8	
Research and scientific institutes	0	0	0			0						0	1	
Sanitary and similar services				1	12	0			0	0	2		31	

Industry Sector/Carcinogenic agent	1,3-Butadiene	Acrylamide	Aromatic amines	Arsenic	Asbestos¹	Benzene	Beryllium	Cadmium	Chromium VI	Cobalt	Diesel engine exhaust	Ethylene oxide	Environmental Tobacco Smoke	Flight personnel
Services allied to transport						0			0	0	26		5	
Shift work														
Water transport						0			0		5		3	
Welfare institutions													5	
Wholesale and retail trade and restaurants and hotels					60	1					5		104	
Total Service industries	0	0	9	1	521	4			1	2	352	0	218	4
TOTAL^{1,2}	1	1	31	113	3909	4	6	8	65	63	652	0	249	4

¹Asbestos related cancers by industry exclude mesotheliomas thought to be para-occupational and environmental in origin, which are included in the total

²Grouped sector subtotals exclude mesotheliomas thought to be para-occupational and environmental in origin, and industry attributable deaths and registrations do not sum to the totals and subtotals due to the method used to combine attributable fractions across exposures

Table 7: Continued: total cancer deaths by industry sector and carcinogenic agent or occupational circumstance

Industry Sector/Carcinogenic agent	Formaldehyde	Hairdressers and barbers	Inorganic lead	Ionising radiation	Leather Dust	Mineral oils	Nickel	Non-arsenical insecticides	Polycyclic Aromatic Hydrocarbons	PAHs - Coal tars and pitches	Painters	Petroleum refining	Radon	Rubber industry
Farming								28					0	
Forestry								1					0	
Horticulture								10						
Total agricultural, hunting, fishing and forestry								39					0	
Beverage industries													1	
Crude petroleum and natural gas production									0					
Electricity, gas and steam				1					0				1	
Food manufacturing								0	0				5	
General industry				0										
Iron and steel basic industries	0		1			0			2	0			1	
Manufacture of electrical machinery, apparatus, appliances and supplies			8										6	
Manufacture of fabricated metal products, except machinery and equipment	0						4		0				3	
Manufacture of footwear					7				0				0	
Manufacture of furniture and fixture, except primary of metal	2												2	
Manufacture of glass and glass products	0								0				0	
Manufacture of industrial chemicals	0		2					1	0				1	
Manufacture of instruments, photographic and optical goods						47							1	
Manufacture of leather and products of leather or of its substitutes					3								0	
Manufacture of machinery except electrical	0			0					0				8	
Manufacture of miscellaneous products of petroleum and coal									0				0	
Manufacture of other chemical products	0		3										2	
Manufacture of other non-metallic mineral products	0								1				1	
Manufacture of paper and paper products									0				1	
Manufacture of plastic products not elsewhere classified	0		8										2	
Manufacture of pottery, china and earthenware									0				1	
Manufacture of rubber products			1						0				1	5
Manufacture of textiles	1												2	
Manufacture of transport equipment							2		0				5	
Manufacture of wearing apparel, except footwear	3								0				2	

Industry Sector/Carcinogenic agent	Formaldehyde	Hairdressers and barbers	Inorganic lead	Ionising radiation	Leather Dust	Mineral oils	Nickel	Non-arsenical insecticides	Polycyclic Aromatic Hydrocarbons	PAHs - Coal tars and pitches	Painters	Petroleum refining	Radon	Rubber industry
Manufacture of wood and wood and cork products, except furniture	1								0				1	
Metal Workers						284								
Mining			0	0			0		0				0	
Non-ferrous metal basic industries	0		6				1		1				1	
Other manufacturing industries													1	
Painters (not construction)											79			
Petroleum refineries									0			0	0	
Printing, publishing and allied industries						233			0				4	
Tobacco manufacture									0				0	
Water works and supply													0	
Welders														
Total manufacturing industry, mining, quarrying, electricity, gas, water	6		28	2	10	563	8	1	4	0	79	0	55	5
Construction	0		25						0				8	
Painters and decorators (construction)											254			
Roofers, road surfacers, Roadmen, Paviers (Construction)										4				
Total Construction	0		25						0	4	254		8	
Air transport														1
Business, professional and other organisation														1
Communication														2
Education services	0													12
Financing, insurance, real estate and business services														23
Flight Personnel				1										
Land transport				0					0					3
Medical, dental, other health and veterinary services	0			0										12
Personal and household services	0	36				0			0					6
Public administration and defence									0					11
Recreational and cultural services														4
Research and scientific institutes	0			0										1
Sanitary and similar services				0					0					2
Services allied to transport									0					1

Industry Sector/Carcinogenic agent	Formaldehyde	Hairdressers and barbers	Inorganic lead	Ionising radiation	Leather Dust	Mineral oils	Nickel	Non-arsenical insecticides	Polycyclic Aromatic Hydrocarbons	PAHs - Coal tars and pitches	Painters	Petroleum refining	Radon	Rubber industry
Shift work														
Water transport									0				0	
Welfare institutions													5	
Wholesale and retail trade and restaurants and hotels									0				37	
Total Service industries	0	36		1		0			0				121	
TOTAL¹	7	36	53	3	10	566	8	40	4	4	334	0	184	5

¹Industry attributable deaths and registrations do not sum to these totals and subtotals due to the method used to combine attributable fractions across exposures

Table 7: Continued: total cancer deaths by industry sector and carcinogenic agent or occupational circumstance

Industry Sector/Carcinogenic Agent	Shift work	Silica	Solar radiation	Soots	Steel foundry workers	Strong inorganic-acid mists with sulfuric acid	TCDD (Dioxins)	Tetrachloroethylene	Tin miners	Trichloroethylene	Ultra Violet	Vinyl chloride	Welders	Wood dust	Overall ²	Rank
Farming			1				35								65	19
Forestry			0				1							0	2	55
Horticulture							11								21	33
Total agricultural, hunting, fishing and forestry			1				47							0	88	
Beverage industries								0						0	4	52
Crude petroleum and natural gas production						0		0						0	4	51
Electricity, gas and steam		5	0					2						0	32	30
Food manufacturing			0					2				0		0	12	39
General industry															0	59
Iron and steel basic industries			0		25	1	46	1						0	84	16
Manufacture of electrical machinery, apparatus, appliances and supplies						10		6		1				0	39	27
Manufacture of fabricated metal products, except machinery and equipment		12	0			12		11		1				0	75	18
Manufacture of footwear														0	7	47
Manufacture of furniture and fixture, except primary of metal														5	22	32
Manufacture of glass and glass products		11	0				31	0						0	49	26
Manufacture of industrial chemicals		1				11	8					1		0	99	14
Manufacture of instruments, photographic and optical goods												0		0	49	25
Manufacture of leather and products of leather or of its substitutes						2		0						0	8	46
Manufacture of machinery except electrical		25				9		16		1				0	91	15
Manufacture of miscellaneous products of petroleum and coal		0													1	58
Manufacture of other chemical products		9				14						1		0	103	13
Manufacture of other non-metallic mineral products		37	0				14					0		0	60	21
Manufacture of paper and paper products						7	6	2						0	51	23
Manufacture of plastic products not elsewhere classified												1		0	11	41
Manufacture of pottery, china and earthenware		33	0			0	25	0							60	20
Manufacture of rubber products														0	7	48
Manufacture of textiles								2						0	17	35
Manufacture of transport equipment		10	0			8		5		1				0	155	10
Manufacture of wearing apparel, except footwear			0					3		0		0		0	10	43
Manufacture of wood and wood and cork products, except furniture			0				11							3	50	24
Metal Workers															284	5

Industry Sector/Carcinogenic Agent	Shift work	Silica	Solar radiation	Soots	Steel foundry workers	Strong inorganic-acid mists with sulfuric acid	TCDD (Dioxins)	Tetrachloroethylene	Tin miners	Trichloroethylene	Ultra Violet	Vinyl chloride	Welders	Wood dust	Overall ²	Rank
Mining		26	0						1						228	8
Non-ferrous metal basic industries		4	0			9	38	0				0		0	119	12
Other manufacturing industries		2												0	4	51
Painters (not construction)															79	17
Petroleum refineries			0					0				0		0	36	28
Printing, publishing and allied industries			0					2						0	243	7
Tobacco manufacture								0						0	0	60
Water works and supply			0					0							3	54
Welders											1		152		153	11
Total manufacturing industry, mining, quarrying, electricity, gas, water		175	1		25	83	179	52	1	3	1	3	152	8	2200	
Construction		614	7					10						10	3457	1
Painters and decorators (construction)															254	6
Roofers, road surfacers, Roadmen, Paviers (Construction)															4	53
Total Construction		614	7					10						10	3694	
Air transport						0		1				0		0	15	37
Business, professional and other organisation			0												2	57
Communication			0					0						0	11	42
Education services								0				0		0	16	36
Financing, insurance, real estate and business services			0												52	22
Flight Personnel															4	49
Land transport			0					3						0	416	4
Medical, dental, other health and veterinary services			0												13	38
Personal and household services			0	59				73		1					556	2
Public administration and defence			2												31	31
Recreational and cultural services			0												12	40
Research and scientific institutes			0					0				0			2	56
Sanitary and similar services			0											0	20	34
Services allied to transport			0					0				0		0	33	29
Shift work	552														552	3
Water transport			0					0				0		0	9	45
Welfare institutions			0												10	44
Wholesale and retail trade and restaurants and hotels			0				6								211	9

Industry Sector/Carcinogenic Agent	Shift work	Silica	Solar radiation	Soots	Steel foundry workers	Strong inorganic-acid mists with sulfuric acid	TCDD (Dioxins)	Tetrachloroethylene	Tin miners	Trichloroethylene	Ultra Violet	Vinyl chloride	Welders	Wood dust	Overall²	Rank
<i>Total Service industries</i>	552		3	59		0	6	78		1		0		0	1955	
TOTAL^{1,2}	552	789	12	59	25	83	231	140	1	4	1	3	152	19	8010	

¹Asbestos related cancers by industry exclude mesotheliomas thought to be para-occupational and environmental in origin, which are included in the total

²Grouped sector subtotals exclude mesotheliomas thought to be para-occupational and environmental in origin, and industry attributable deaths and registrations do not sum to the totals and subtotals due to the method used to combine attributable fractions across exposures

Table 8 Total cancer registrations by industry sector and carcinogenic agent or occupational circumstance

Industry Sector/Carcinogenic agent	1,3-Butadiene	Acrylamide	Aromatic amines	Arsenic	Asbestos ¹	Benzene	Beryllium	Cadmium	Chromium VI	Cobalt	Diesel Engine Exhaust	Ethylene oxide	Environmental Tobacco Smoke	Flight personnel
Farming														
Forestry														
Horticulture														
<i>Total agricultural, hunting, fishing and forestry</i>														
Beverage industries						0			0	0	3			
Crude petroleum and natural gas production						0			0	0	5	0		
Electricity, gas and steam				1	19		0		0	0	2			
Food manufacturing									0	4	2	0		
General industry														
Iron and steel basic industries			16			0			0		0			
Manufacture of electrical machinery, apparatus, appliances and supplies				6			0	1	1	1	1			
Manufacture of fabricated metal products, except machinery and equipment							0		26	11	2			
Manufacture of footwear									0					
Manufacture of furniture and fixture, except primary of metal				8					0	7	0			
Manufacture of glass and glass products				7			0		0	1	0			
Manufacture of industrial chemicals	0	1	0	3	64	0		1	4	6	1			
Manufacture of instruments, photographic and optical goods							0		0	2	0			
Manufacture of leather and products of leather or of its substitutes				8					0	0				
Manufacture of machinery except electrical							6		28	5	2			
Manufacture of miscellaneous products of petroleum and coal						0					0			
Manufacture of other chemical products	0	0		0	69	0			2	10	1	0		
Manufacture of other non-metallic mineral products				1					0	0	7			
Manufacture of paper and paper products	0				37				0	1	1			
Manufacture of plastic products not elsewhere classified	0		0			0			0	1	0			
Manufacture of pottery, china and earthenware									0	1				
Manufacture of rubber products	1	0	0						0	0				
Manufacture of textiles			23						0	0	1			
Manufacture of transport equipment				0	115		0		18	4	2			
Manufacture of wearing apparel, except footwear									0	1	1			

Industry Sector/Carcinogenic agent	1,3-Butadiene	Acrylamide	Aromatic amines	Arsenic	Asbestos ¹	Benzene	Beryllium	Cadmium	Chromium VI	Cobalt	Diesel Engine Exhaust	Ethylene oxide	Environmental Tobacco Smoke	Flight personnel
Manufacture of wood and wood and cork products, except furniture				35					0	2	2			
Metal Workers														
Mining					192						43			
Non-ferrous metal basic industries				50		0		6	3	6	2			
Other manufacturing industries			0	0					1	0	0			
Painters (not construction)														
Petroleum refineries	0			0	38	0			0	0	0			
Printing, publishing and allied industries									0	4	0			
Tobacco manufacture											0			
Water works and supply											2			
Welders														
Total manufacturing industry, mining, quarrying, electricity, gas, water	1	1	48	113	535	0	7	9	86	67	80	0		
Construction				15	2773				0	4	290		36	
Painters and decorators (construction)														
Roofers, road surfacers, Roadmen, Paviers (Construction)														
Total Construction				15	2773				0	4	290		36	
Air transport						0			0	2	3		11	
Business, professional and other organisation													1	
Communication											3		7	
Education services	0		0			0							4	
Financing, insurance, real estate and business services													33	
Flight Personnel														13
Land transport					133	1			0		350		3	
Medical, dental, other health and veterinary services	0		0									0		
Personal and household services			18		361	5			2		29		22	
Public administration and defence											1		20	
Recreational and cultural services				0									9	
Research and scientific institutes	0	0	0			0						0	1	
Sanitary and similar services				1	13	0			0	0	2		3	
Services allied to transport						0			0	0	33		6	
Shift work														

Industry Sector/Carcinogenic agent	1,3-Butadiene	Acrylamide	Aromatic amines	Arsenic	Asbestos¹	Benzene	Beryllium	Cadmium	Chromium VI	Cobalt	Diesel Engine Exhaust	Ethylene oxide	Environmental Tobacco Smoke	Flight personnel
Water transport						0			0		6		4	
Welfare institutions													5	
Wholesale and retail trade and restaurants and hotels					66	1					6		118	
Total Service industries	0	0	18	1	573	7			3	2	431	0	248	13
TOTAL^{1,2}	1	1	66	129	4216	7	7	9	89	73	801	1	284	13

¹Asbestos related cancers by industry exclude mesotheliomas thought to be para-occupational and environmental in origin, which are included in the total

²Grouped sector subtotals exclude mesotheliomas thought to be para-occupational and environmental in origin, and industry attributable deaths and registrations do not sum to the totals and subtotals due to the method used to combine attributable fractions across exposures

Table 8: Continued: total cancer registrations by industry sector and carcinogenic agent or occupational circumstance

Industry Sector/Carcinogenic agent	Formaldehyde	Hairdressers and barbers	Inorganic lead	Ionizing radiation	Leather Dust	Mineral oils	Nickel	Non-arsenical pesticides	Polycyclic Aromatic Hydrocarbons	PAHs - Coal tars and pitches	Painters	Petroleum refining	Radon	Rubber industry
Farming								51						1
Forestry								2						0
Horticulture								19						
Total agricultural, hunting, fishing and forestry								72						1
Beverage industries														1
Crude petroleum and natural gas production									0					
Electricity, gas and steam				2					0					2
Food manufacturing								0	0					6
General industry				0										
Iron and steel basic industries	0		2			0			3	4				1
Manufacture of electrical machinery, apparatus, appliances and supplies			10											7
Manufacture of fabricated metal products, except machinery and equipment	0						5		0					4
Manufacture of footwear					22				0					1
Manufacture of furniture and fixture, except primary of metal	3													2
Manufacture of glass and glass products	0								0					0
Manufacture of industrial chemicals	0		2					1	1					2
Manufacture of instruments, photographic and optical goods						203								1
Manufacture of leather and products of leather or of its substitutes					10									0
Manufacture of machinery except electrical	0			0					0					9
Manufacture of miscellaneous products of petroleum and coal									0					0
Manufacture of other chemical products	0		3											2
Manufacture of other non-metallic mineral products	0								2					1
Manufacture of paper and paper products									0					2
Manufacture of plastic products not elsewhere classified	0		9											2
Manufacture of pottery, china and earthenware									0					1
Manufacture of rubber products			1						0					1
Manufacture of textiles	1													3
Manufacture of transport equipment							2		0					5
Manufacture of wearing apparel, except footwear	5								0					3

Industry Sector/Carcinogenic agent	Formaldehyde	Hairdressers and barbers	Inorganic lead	Ionizing radiation	Leather Dust	Mineral oils	Nickel	Non-arsenical pesticides	Polycyclic Aromatic Hydrocarbons	PAHs - Coal tars and pitches	Painters	Petroleum refining	Radon	Rubber industry
Manufacture of wood and wood and cork products, except furniture	1								0					2
Metal Workers						1,252								
Mining			0	0			0		0					0
Non-ferrous metal basic industries	0		8				2		1					1
Other manufacturing industries														1
Painters (not construction)											102			
Petroleum refineries									0			0		0
Printing, publishing and allied industries						267			0					4
Tobacco manufacture									0					0
Water works and supply														0
Welders														
Total manufacturing industry, mining, quarrying, electricity, gas, water	11		34	2	31	1722	9	2	8	4	102	0	62	9
Construction	0		31						0					9
Painters and decorators (construction)											334			
Roofers, road surfacers, Roadmen, Paviers (Construction)										471				
Total Construction	0		31						0	471	334			9
Air transport														1
Business, professional and other organisation														1
Communication														3
Education services	0													14
Financing, insurance, real estate and business services														26
Flight Personnel				1										
Land transport				0					0					4
Medical, dental, other health and veterinary services	1			0										14
Personal and household services	0	63				0			0					6
Public administration and defence									0					12
Recreational and cultural services														4
Research and scientific institutes	0			0										1
Sanitary and similar services				0					0					2
Services allied to transport									0					1

Industry Sector/Carcinogenic agent	Formaldehyde	Hairdressers and barbers	Inorganic lead	Ionizing radiation	Leather Dust	Mineral oils	Nickel	Non-arsenical pesticides	Polycyclic Aromatic Hydrocarbons	PAHs - Coal tars and pitches	Painters	Petroleum refining	Radon	Rubber industry
Shift work														
Water transport									0				1	
Welfare institutions													6	
Wholesale and retail trade and restaurants and hotels									0				42	
Total Service industries	1	63		1		0			0				137	
TOTAL¹	12	63	65	4	31	1722	9	73	8	475	437	0	209	9

¹ Industry attributable deaths and registrations do not sum to the totals and subtotals due to the method used to combine attributable fractions across exposures

Table 8: Continued: Total cancer registrations by industry sector and carcinogenic agent or occupational circumstance

Industry Sector/Carcinogenic agent	Shift work	Silica	Solar radiation	Soots	Steel foundry workers	Strong inorganic-acid mists with sulphuric acid	TCDD (Dioxins)	Tetrachloroethylene	Tin miners	Trichloroethylene	Ultra Violet	Vinyl chloride	Welders	Wood dust	Overall ²	Rank
Farming			128				41								220	12
Forestry			7				1							1	11	50
Horticulture							13								31	36
Total agricultural, hunting, fishing and forestry			135				55							1	263	
Beverage industries								0						0	4	55
Crude petroleum and natural gas production						0		0						0	5	53
Electricity, gas and steam		6	53					3						0	88	25
Food manufacturing			1					2				0		0	15	45
General industry															0	59
Iron and steel basic industries			0		29	3	75	1						0	135	17
Manufacture of electrical machinery, apparatus, appliances and supplies						15		7		1				0	49	32
Manufacture of fabricated metal products, except machinery and equipment		14	1			17		13		1				0	94	23
Manufacture of footwear														0	22	39
Manufacture of furniture and fixture, except primary of metal														13	34	35
Manufacture of glass and glass products		12	1				43	0						0	64	29
Manufacture of industrial chemicals		1				16	11					1		0	116	19
Manufacture of instruments, photographic and optical goods												0		0	206	13
Manufacture of leather and products of leather or of its substitutes						2		0						0	20	40
Manufacture of machinery except electrical		28				13		18		1				0	111	20
Manufacture of miscellaneous products of petroleum and coal		1													1	58
Manufacture of other chemical products		10				20						1		0	119	18
Manufacture of other non-metallic mineral products		43	1				19					0		0	73	26
Manufacture of paper and paper products						9	7	2						0	59	31
Manufacture of plastic products not elsewhere classified												1		0	14	46
Manufacture of pottery, china and earthenware		38	23			0	35	0							98	22
Manufacture of rubber products														0	11	49
Manufacture of textiles								3						0	31	37
Manufacture of transport equipment		11	5			12		6		1				0	182	14

Industry Sector/Carcinogenic agent	Shift work	Silica	Solar radiation	Soots	Steel foundry workers	Strong inorganic-acid mists with sulphuric acid	TCDD (Dioxins)	Tetrachloroethylene	Tin miners	Trichloroethylene	Ultra Violet	Vinyl chloride	Welders	Wood dust	Overall ²	Rank
Manufacture of wearing apparel, except footwear			1					3		0		0		0	13	48
Manufacture of wood and wood and cork products, except furniture			2				14							8	66	28
Metal Workers															1252	3
Mining		29	31						1						296	8
Non-ferrous metal basic industries		4	9			14	50	1				0	0	0	156	16
Other manufacturing industries		2												0	5	54
Painters (not construction)															102	21
Petroleum refineries			7					0				0	0	0	46	33
Printing, publishing and allied industries			3					2						0	282	9
Tobacco manufacture								0						0	0	60
Water works and supply			26					0							29	38
Welders											6	175			181	15
Total manufacturing industry, mining, quarrying, electricity, gas, water		200	163		29	122	254	60	1	5	6	3	175	23	3909	
Construction		707	841					11						29	4,668	1
Painters and decorators (construction)															334	7
Roofers, road surfacers, Roadmen, Paviers (Construction)															471	6
Total Construction		707	841					11						29	5439	
Air transport						0		1				0	0	0	18	42
Business, professional and other organisation			1												3	56
Communication			5					0						0	17	43
Education services								0				0	0	0	18	41
Financing, insurance, real estate and business services			3												63	30
Flight Personnel															14	47
Land transport			6					3						0	498	5
Medical, dental, other health and veterinary services			1												16	44
Personal and household services			14	60				89		2					670	4
Public administration and defence			240												273	10
Recreational and cultural services			55												69	27
Research and scientific institutes			1					0				0			3	57

Industry Sector/Carcinogenic agent	Shift work	Silica	Solar radiation	Soots	Steel foundry workers	Strong inorganic-acid mists with sulphuric acid	TCDD (Dioxins)	Tetrachloroethylene	Tin miners	Trichloroethylene	Ultra Violet	Vinyl chloride	Welders	Wood dust	Overall²	Rank
Sanitary and similar services			68											0	90	24
Services allied to transport			3					0				0		0	43	34
Shift work	1,957														1957	2
Water transport			1					0				0		0	11	52
Welfare institutions			0												11	51
Wholesale and retail trade and restaurants and hotels			6				7								246	11
Total Service industries	1957		402	60		0	7	94		2		0		1	4007	
TOTAL^{1,2}	1957	907	1541	60	29	122	316	164	1	7	6	3	175	54	13598	

¹Asbestos related cancers by industry exclude mesotheliomas thought to be para-occupational and environmental in origin, which are included in the total

²Grouped sector subtotals exclude mesotheliomas thought to be para-occupational and environmental in origin, and industry attributable deaths and registrations do not sum to these totals and subtotals due to the method used to combine attributable fractions across exposures

3.4 DEATHS AND REGISTRATIONS BY INDUSTRY SECTOR AND CANCER SITE

Tables 9 and 10 give total deaths and total registrations respectively, by industry sector and for each cancer site. Numbers of deaths and registrations for males, females and the total are available on the HSE website, together with the respective attributable fractions. The totals and ranking for industry sector for Tables 9 and 10 are the same as in Tables 7 and 8 respectively.

In addition to the contribution of multiple carcinogens in many industry sectors these tables highlight the multiplicity of types of cancer within industry sectors. For example, from Table 10, there are 7 for farming (brain, leukaemia, lung, multiple myeloma, non-Hodgkin's lymphoma, NMSC, soft tissue sarcoma), (9 for construction (bladder, brain, larynx, lung, mesothelioma, NMSC, oesophagus, sinonasal and stomach), and 12 for personal and household services (bladder, cervix, kidney, leukaemia, lung, mesothelioma, non-Hodgkin's lymphoma, oesophagus, ovary, sinonasal, stomach).

Table 9 Total deaths by industry sector and cancer site

Industry Sector/Cancer site	Bladder	Bone	Brain	Breast	Cervix	Kidney	Larynx	Leukaemia	Liver	Lung	LH	Melanoma_eye	Mesothelioma ¹
Farming			7					8		35			
Forestry			0					0		1			
Horticulture			2					3		11			
Total agricultural, hunting, fishing and forestry			9					11		47			
Beverage industries	0				0			0		3			
Crude petroleum and natural gas production	0				0		0	0		4			
Electricity, gas and steam	0	0			0		0	0	0	19			9
Food manufacturing	0		0		0			0	0	10			
General industry		0						0	0	0			
Iron and steel basic industries	9		0		0		1	0		52			
Manufacture of electrical machinery, apparatus, appliances and supplies	0		0		0	0	2		0	28			
Manufacture of fabricated metal products, except machinery and equipment	0				1	0	2	0	0	60			
Manufacture of footwear										0			
Manufacture of furniture and fixture, except primary of metal	0							2		16			
Manufacture of glass and glass products	0				0			0		42			
Manufacture of industrial chemicals	0		0				2	0	1	61	0		30
Manufacture of instruments, photographic and optical goods	19								0	28			
Manufacture of leather and products of leather or of its substitutes	3				0		0			2			
Manufacture of machinery except electrical	0	0			1	0	2	0	0	71			
Manufacture of miscellaneous products of petroleum and coal	0							0		0			
Manufacture of other chemical products	0		0				3	0	1	66	0		32
Manufacture of other non-metallic mineral products	1							0	0	56			
Manufacture of paper and paper products	0				0		1	0		31	0		17
Manufacture of plastic products not elsewhere classified	0		0					0	1	8	0		
Manufacture of pottery, china and earthenware					0		0			54			
Manufacture of rubber products	0		0				1	0		1	0		
Manufacture of textiles	11				0			1		3			
Manufacture of transport equipment	0				0	0	2		0	92			54
Manufacture of wearing apparel, except footwear	0				0	0		2	0	4			
Manufacture of wood and wood and cork products, except furniture	0							1		46			
Metal Workers	112									152			
Mining	3	0	0					0	0	214			9

