

# CHEMICAL HAZARDS HANDBOOK

A workers' guide to chemical hazards and how to avoid them

BECKY ALLEN  
for  
LONDON HAZARDS  
CENTRE

## Chemical Hazards Handbook

A workers' guide to chemical hazards and how to avoid them

This handbook provides a broad, practical understanding of how to deal with issues of chemical safety at work. It explains how chemicals act, how to measure the danger, what legislation applies, the prevention and control of hazards and campaigning and taking action.

It will help people at work to assess the reliability of the information on chemicals and safety measures provided by employers, manufacturers, suppliers and expert sources. It provides the tools required to interpret chemical information and to form a plan of action to eliminate or reduce the risks posed by exposure to chemicals.

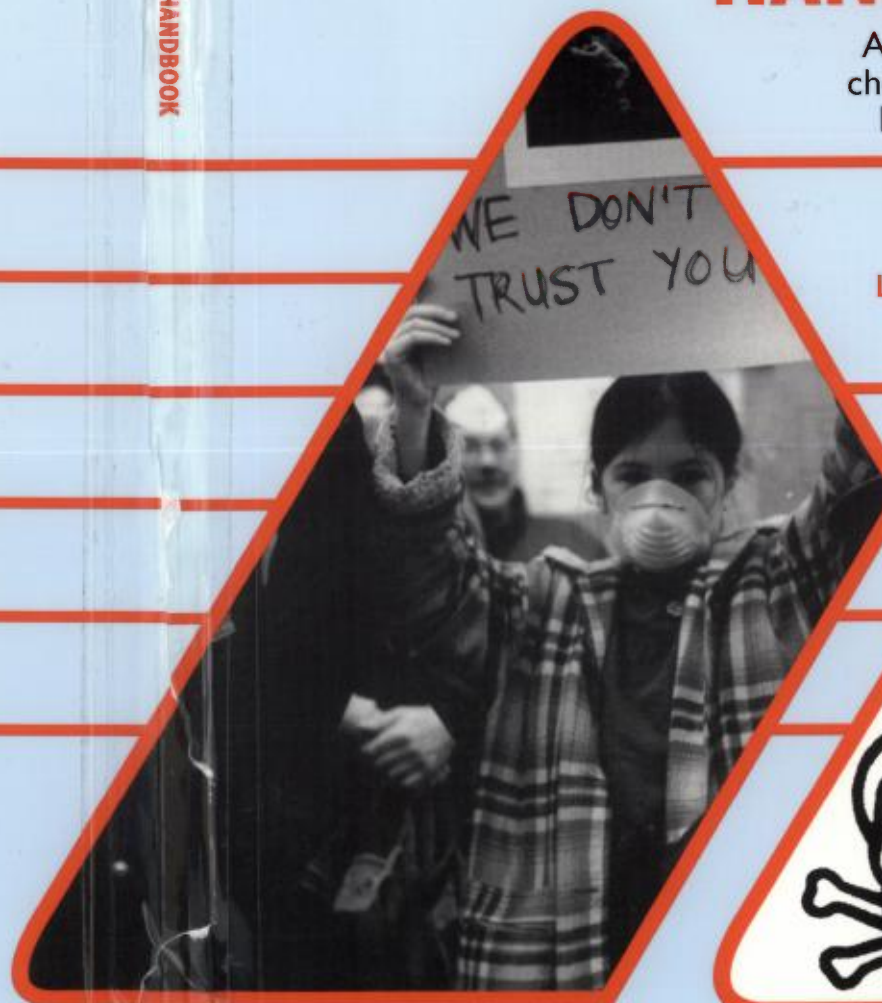
It is aimed at trade union safety representatives and other who do not have a chemistry background. It is not a directory of hazardous chemicals.



£15 (£7 to trade unions, community groups, tenants' and residents' associations when ordered directly from London Hazards Centre)

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A London Hazards Centre Handbook

## ABOUT THE LONDON HAZARDS CENTRE

### Advice service

The London Hazards Centre provides a free advice and information service on occupational and environmental hazards to workplace and community groups in London. We aim to help those Londoners who do not have access to commercial or academic resources. We give priority to those with the most dangerous living or working conditions.

### Information resources

The Centre's library contains information from workplace and campaign groups, as well as official and scientific publications. We receive bulletins from health and safety organisations all over the world. The collection is backed up by our computerised catalogue HAZLIT (accessible via e-mail) and by major technical databases in easy-to-use compact disk form. The library has been designated a WHO Practical Information Centre under the International Programme on Chemical Safety.

### Research and briefing service

We offer a research and briefing service to trade unions, local authorities, solicitors, journalists, media researchers and others working to combat hazardous working and living conditions.

### Training

We offer training on basic health and safety law, procedures and good practice. We cover general health and safety, the control and substitution of hazardous substances, asbestos, VDUs and RSI, safety representatives' rights, violence at work, stress, and lifting and handling.

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# **CHEMICALS HAZARDS HANDBOOK**

**A workers' guide to  
the hazards of chemicals  
and how to avoid them**

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## ACKNOWLEDGEMENTS

This book was written for the London Hazards Centre by Becky Allen. Many other people contributed information without which the book could not have been written. Particular thanks are due to all those victims of chemical poisoning whose stories are told in the case studies in the book. Their experiences stand out among the legal and scientific detail and demonstrate the fundamental reason why the Centre decided to publish this handbook. Invaluable assistance was provided by the HSE Press Office, Tom Jones, and Kim Sunley.

The manuscript was commented on by Alan Dalton, Fiona Murie, Hilda Palmer, and Andrew Watterson, for whose help and advice we are extremely grateful. Any errors that remain are entirely the responsibility of the Centre.

The book is aimed at trade union safety representatives who deal with chemical safety on a daily basis but who do not have a chemistry background. Hopefully, it will also be of interest to everyone else with an interest in the hazards of chemicals at work. As far as possible, it has been written in a style accessible to the general reader without distorting the accuracy of the information. It will be for our readers to decide if we have achieved our aim.

*Hugh MacGrillen*  
*London Hazards Centre*  
*February 1999*

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## CONTENTS

Acknowledgements	i
Glossary	iii
1 Introduction	1
2 Chemicals and chemistry	6
3 The legal framework	47
4 Prevention and control of chemical hazards	71
5 Taking action – issues and organisations	87
6 Contacts and resources	95
Index	101

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## GLOSSARY

**Acop** Approved Code of Practice

**ACTS** Advisory Committee on Toxic Substances

**ALARP** as low as reasonably practicable

**asthmagen** substance which causes asthma

**BMGV** biological monitoring guidance value

**carcinogen** substance which causes cancer

**cardiovascular system** the heart and blood vessels

**CHAN** Chemical Hazard Alert Notice

**CHIP** Chemicals (Hazard Information and Packaging for Supply) Regulations

**COSHH** Control of Substances Hazardous to Health Regulations

**cytotoxic** cell poison

**dyspnoea** tight chestedness

**EH40** Occupational Exposure Limits

**EH64** Summary Criteria for Occupational Exposure Limits

**emphysema** lung disease characterised by breathlessness and barrel chest

**encephalopathy** any disorder of the brain

**epidemiology** study of the distribution and causes of disease in specific populations

**erythrocyte** red blood cell

**genotoxin** substance that damages genetic material

**haematotoxin** blood poison

**hepatotoxin** liver poison

**HSC** Health and Safety Commission

**HSE** Health and Safety Executive

***in vitro*** experiments in test tubes or culture media

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***in vivo*** experiments on live animals

**intraperitoneal** within the abdomen

**LC<sub>50</sub>** lethal concentration 50%

**LD<sub>50</sub>** lethal dose 50%

**lymphocyte** type of white blood cell involved in the immune system

**MEL** Maximum Exposure Limit

**mesothelioma** cancer of lining of the chest

**mg/m<sup>3</sup>** milligrams per cubic metre

**mutagen** substance that causes mutations in cells

**neoplasm** tumour

**nephrotoxin** kidney poison

**neurotoxin** nerve poison

**NOAEL** no observed adverse effect level

**oedema** build-up of fluid in cells or tissues

**OEL** occupational exposure limit

**OES** Occupational Exposure Standard

**PPE** personal protective equipment

**ppm** parts per million

**RPE** respiratory protective equipment

**teratogen** substance which causes birth defects

**TUR** toxics use reduction

**urticaria** nettle rash-like skin reaction

**WATCH** Working Group on the Assessment of Toxic Chemicals,  
sub-committee of **ACTS**

## INTRODUCTION

There were over 7000 major chemical incidents worldwide in the period 1986–97 according to the Major Hazard Incident Data Service (MHIDAS) database. These were publically reported incidents which caused casualties, required evacuation of workers or people nearby or damaged property or the environment. The rate of occurrence of published incidents is increasing as reporting improves and the chemical industry expands. These incidents do not include long-term exposures to chemicals.

The worst chemical disaster took place in Bhopal in India in 1984. In a Union Carbide pesticide plant, the introduction of water into a tank of methyl isocyanate resulted in the release of a massive quantity of lethal gas over the surrounding neighbourhood. About 2500 people died within hours. Estimates of the number of deaths subsequently have ranged as high as 12,000. Huge numbers of people suffered damage to their health, permanently in many cases. The Indian Council of Medical Research estimated in 1991 that more than 520,000 people were affected.

Arguments about the cause of the Bhopal tragedy have never ceased. The company has never accepted responsibility and has hinted that sabotage took place. But workers in the plant tell a very different story, pointing to sloppy operation and storage procedures, non-functional safety systems, poor maintenance and inadequate staffing and training. The company has only ever offered derisory compensation, neither the Indian nor the US Government have made any real effort to bring the company to book, and to this day a world-wide campaign continues to obtain justice for the victims. A number of major incidents have also occurred at Union Carbides's US plants.

In the United Kingdom, the chemical accident resulting in the greatest loss of life took place in Flixborough in 1974; 28 workers died when a Nypro Ltd. cyclohexane plant blew up. A Court of Inquiry found that the accident resulted from the ignition and detonation of a huge quantity of cyclohexane which escaped when a temporary by-pass between two reactors broke. The by-pass had not been properly engineered as the company had not taken the possibility of such an accident into account.

After a major chemical release at Associated Octel in 1996, 22 years later, the Health and Safety Executive gave more or less the same recommendation that "chemical companies should make a thorough and detailed assessment of risks to prevent the loss of dangerous chemicals and which should be routinely reviewed and kept up to date..."

The facts of chemical-induced illness are no less horrifying. For instance, in 1990, the World Health Organisation published an estimate that there were 25 million cases per year of acute occupational pesticide poisoning among agricultural workers in developing countries. The Chinese government admitted that in 1993 more than 10,000 Chinese farmers died from poisoning by sub-standard pesticides. A Mexican consumer group has claimed that about 5000 Mexicans die from pesticide poisoning each year.

In Great Britain, two surveys of self-reported work-related illness were carried out in 1990 and 1995. In the latter survey over 200,000 people reported that they had contracted asthma or other respiratory illness at work and 66,000 said they suffered from job-related skin disease. In only 11 per cent of the cases that were checked did the treating doctor fundamentally disagree about the cause of the illness. These figures are vastly in excess of those obtained from the Industrial Injuries Scheme or from academic medical units. Successful new claimants each year for disablement benefit for occupational asthma are numbered in hundreds. Those claiming for occupational dermatitis are even fewer. In analysing this discrepancy, the HSE commented that, "People's beliefs may be mistaken." They did not consider the possibility that the beliefs of the medical profession, lawyers and politicians trying to limit expenditure on social security might also be mistaken. But it is not disputed that there is massive under-reporting through the official channels.

Chemicals pervade the workplace and affect practically every worker. Even in the cleanest, most modern office workers are exposed routinely to inks, toners and adhesives not to mention a wide range of materials used in cleaning and maintenance. Millions worldwide are employed in the manufacture, storage and transport of chemicals and many more in their ultimate application. In addition to the well publicised disasters, there are everyday accidents and illnesses which take a huge toll.

The number and variety of chemicals are vast. The number of chemicals recorded by the Chemical Abstracts Service, the main international registry, was approaching 19 million in November 1998 and increasing at a rate of more than 30,000 per week. The minimum estimate of those which find

commercial application is 100,000; the number may range as high as 400,000. Yet, of these, only the properties of about 400 are known with any certainty and even these are sometimes subject to changes and refinements in understanding.

It is these factors: a) the hazardous nature of chemicals, b) their huge number and variety, c) the inadequate knowledge of their properties, d) the lack of effective controls and e) the vast number of people at risk which make chemical safety at work such an important topic. It ought to be the subject of consultation and negotiation between workers and employers at every level. For example, the International Labour Organisation adopted a Convention and a Recommendation on chemical safety in 1990 and followed up with a Code of Practice in 1992.

These documents make the point that workers and their representatives have rights on chemical safety which include:

- ▲ the provision of information from the employer and from manufacturers and suppliers to enable them to take adequate precautions against the risks of hazardous chemicals
- ▲ the ability to request and participate in investigations of the possible risks from workplace chemicals
- ▲ workers being entitled to bring the hazards of chemicals to the attention of their employer and their representatives without suffering reprisals
- ▲ workers being able to remove themselves from danger when there is reasonable justification to believe there is a serious and imminent risk
- ▲ the removal to alternate work away from chemical exposure whenever their health requires it
- ▲ compensation for damage to health or loss of employment caused by the effects of chemicals
- ▲ adequate medical treatment for injuries and diseases caused by chemicals.

In order to exercise these rights or to campaign for them where they do not exist, workers and their representatives must be able to evaluate information on chemical risks and hazards whether they receive it from their employers, government bodies, academic sources or even their own organisations. It is the purpose of this book to assist them to do so.

There are considerable hurdles to be overcome by anyone without a scientific background who wishes to get to grips with chemical information:

- ▲ there have been occasions when the information in the public domain has simply been false or insufficient. The sorry story of the asbestos industry is proof enough; the companies withheld or distorted information for several decades before the true facts became established. As recently as 1996, over 50 leading environmental health scientists felt impelled to launch a protest to the International Programme on Chemical Safety, part of the World Health Organisation, at what they regarded as the improper influence of business interests on the IPCS's documents on white asbestos. The role of the US Government in suppressing research on the effects of the defoliant Agent Orange is another example
- ▲ the scanty information available about almost all chemicals present in the workplace. Even for those which have been around for a long time, new data emerge which require long-held views to be modified. A case in point is lead, which has been in use for 4000 years, where new research is leading to progressive reductions in the level at which harmful effects might be expected to occur
- ▲ the technical format in which information is presented which makes it inaccessible for all except highly qualified specialists
- ▲ the tendency of many experts to dismiss the observations and experiences of ordinary people as a basis for scientific inquiry compared with the findings of conventional research methods

It is not surprising therefore that many workers and their representatives, while sceptical of the information offered by their employers and the authorities, also feel that they are unable to challenge it. It is the objective of this book to provide ordinary workers with some tools by which they can evaluate information on the hazards of chemicals and therefore take decisions which can maximise their safety. It is not that we dismiss conventional scientific knowledge as intrinsically biased or unsound but we do insist that the assembly of standards, limits and protective measures governing chemicals is a social process which is driven by economic and political values among which the health and safety of workers is not the sole or even a major consideration. But, a perfectly valid argument can be made on the maximum degree of safety from the standpoint of those who face the risks and this is the one which the London Hazards Centre believes should be given primacy.

This book is not a compilation of exposure limits or a list of the toxic properties of chemicals. Instead it tries to present an account of the underlying principles which have enabled this information to be derived.

The way in which chemicals act is described along with an introduction to the methods which have been developed to measure the effects. The safety legislation which applies in the United Kingdom is outlined and suggestions are made on how it could be improved. A critique is provided of methods to control and prevent chemical hazards, not just by technical means but also by management systems; the role of trade union safety representatives is emphasised. Finally attention is drawn to the campaigns which are being waged by unions and other organisations against chemical hazards and which play an indispensable role in pushing up safety standards. Overall, the focus is on workplace hazards and their effect on the employees and members of the general public who are affected. If inadequate attention has been given to environmental factors, it is not because we don't believe this subject is hugely important, but simply because it would have expanded the book to an enormous extent. However, the drive for profit which leads the chemical industry to damage the environment is not much different from that which produces injury and illness among employees.

There are two further principles which we think should be added to those put forward by the ILO. The first is that when the introduction of new chemicals into the workplace is contemplated, the onus should be on the employer to prove that they are safe rather than on the workers or the union to prove they are dangerous – the precautionary principle. Too often, that proof was provided by human guinea pigs with a mounting casualty list before appropriate action was taken. That sequence of events will be repeated as long as it is possible to bring in new chemicals without adequate testing of both short- and long-term effects. The other principle is that there should be no detriment, at a minimum, of the health, safety and well-being of workers as a result of their work. Work should enhance the health and well-being of those who perform it. But, at the least, any harmful effects are unacceptable. Working conditions which produce such effects must be changed. If our book assists any workers and their representatives to move in this direction, then our objective in publishing it has been fulfilled.

*Hugh MacGrillen*  
*London Hazards Centre*

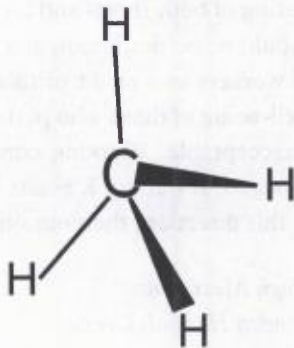
## CHEMICALS AND CHEMISTRY

Everything around us – animal, vegetable and mineral – is made up of chemicals. Some are simple substances such as the water molecule, which is made up of hydrogen and oxygen atoms, and others are very complicated compounds made up of many different chemical elements. As well as naturally occurring chemical compounds, scientists have created millions more in the past 100 years that do not exist in nature. Chemicals come as powders, pellets, dusts, liquids, vapours, gases, etc.

Chemists tend to divide the world into inorganic and organic compounds, largely depending on whether they contain the element carbon. Carbon-containing compounds were originally described as organic because many of them came from nature. Since then, chemists have synthesised many organic compounds, many of which are important in industrial products and processes. The organic solvents and organophosphate pesticides involved in the case studies (see later) are just a few examples of these organic compounds. Inorganic materials, comprising metals, minerals and salts, among other types, are much less likely to contain carbon.

### What's in a name?

Individual chemical compounds are described by their formulae, such as  $\text{H}_2\text{O}$  for water and  $\text{CH}_4$  for methane. A chemical formula describes the number of atoms of each element making up the compound, whereas the structure describes the arrangement of these atoms. The structure of the gas methane, for example, is shown in Figure 1. The molecule is not flat but a three-dimensional tetrahedron, with the carbon atom in the centre and a hydrogen at each of the four corners.



**Figure 1:**  
Structure of methane,  $\text{CH}_4$

Chemical structure is not just of academic interest. It affects how chemicals react with each other, and with biological systems, including humans and the environment. It is common for chemicals with the same formula to have different structures (called isomers), and therefore have different properties and toxicity. In fact, the seemingly small difference of one molecule being the mirror image of the other (called stereoisomers) can cause major differences in their biological effects.

Table 1 illustrates some of the properties of 1,1,2-trichloroethane and 1,1,1-trichloroethane, which differ because they have different structures even though they have the same formula. One is about 15 times more toxic to rats than the other.

**Table 1**

	1,1,1-trichloroethane	1,1,2-trichloroethane
formula	$C_2H_3Cl_3$	$C_2H_3Cl_3$
structure	$CH_3CCl_3$	$CH_2ClCHCl_2$
CAS registry number	71-55-6	79-00-5
boiling point	74.1°C	114°C
UK OES	200 ppm	none
oral LD50 (rat)	11,000–14,300 mg/kg	836 mg/kg

*The dictionary of substances and their effects* volume 7, The Royal Society of Chemistry, 1994

Although certain rules apply to naming chemicals, most chemicals are known by more than one name, or synonym, and some also have trade names. This means that finding information on specific chemicals can appear complicated but useful information can be gleaned by non-chemists and this becomes easier with familiarity and practice. When searching for information on a chemical, it is always useful to know its CAS registry number. This number is assigned by the US Chemical Abstracts Service, and each chemical has its own unique number. This system is accepted globally. Many books and databases of chemicals are indexed by CAS registry number.

## Properties

As well as their formula and structure, chemists describe a great many properties of a chemical. Some of these are also important to the toxicologist or industrial hygienist because they tell us how a chemical behaves in various situations.

According to its boiling point and melting point, a chemical will be a solid, liquid or gas at room temperature and pressure. This is known as the chemical's physical state, and this changes with temperature and pressure. Water, for example, changes from a solid to a liquid to a gas between 0 and 100°C. A chemical's physical state, coupled with other properties such as its volatility, will influence the likelihood of its entry into the human body by various routes of exposure.

Several other properties influence the effect of chemicals:

**Vapour density:** the weight of a volume of a gaseous chemical compared with the weight of the same volume of air. If the vapour density is greater than 1, the gas is heavier than air and will tend to collect at floor level where it can be a fire or explosion hazard. In confined spaces, gases with vapour density less than 1 may replace air in the space, so that there is a danger of suffocation

**Vapour pressure:** describes how fast a solid or liquid evaporates, and increases with increasing temperature. A liquid which evaporates easily into the air is more likely to be inhaled

**Flash point:** describes the temperature at which a substance gives off enough vapour to form a mixture with air which can be ignited by a spark or flame

**Autoignition temperature:** the lowest temperature at which a substance burns without a spark or flame

**Explosive or flammability limits:** an upper and lower concentration of a gas or vapour in air, between which it may explode if ignited by a spark or flame

The properties of hundreds of chemicals are published in several books [Dangerous Properties of Industrial Materials (known as Sax), Merck Index, The Dictionary of Substances and their Effects (DOSE)], web sites, and on safety data sheets.

## Toxicity

How poisonous – or toxic – a chemical is depends on the nature of the chemical itself, including its structure and properties. But its potential to cause harm to workers also depends on the dose and duration of exposure, as well as other factors.

The word ‘toxic’ comes from the Greek *toxicon* or arrow-poison. The word toxic is the root of many terms covered in the following sections, such as toxicity (how toxic a substance is) and toxicology (the study of poisons).

“Toxicology is the study of the harmful effects of chemicals on biological systems. It is a hybrid science built on advances in biochemistry, physiology, pathology, physical chemistry, pharmacology, and public health.” (H. Frumkin in Levy and Wegman)

“It is probably safe to say that the mechanism of action of no chemical is understood in every detail. Toxicologists know a great deal about a few chemicals, a little about many, and next to nothing about most” (J.V. Rodricks p. 146).

The following sections describe how chemicals enter the body (routes of exposure), and the effects that they can have on various parts of the body. We will look at the time-scale over which these effects operate, so-called acute and chronic effects, and how certain combinations of chemicals are much more toxic together than would be predicted by adding up the damage they do on their own.

Finally, we will look at the many ways in which scientists study and measure toxicity, so that toxicity information in books, journals and safety data sheets can be interpreted more easily. Many of these issues are also illustrated by case studies.

## Routes of exposure

Chemicals enter the body by three main routes: through the lungs (inhalation); through the skin (dermal absorption); and by being swallowed (ingestion). They can also enter through the eyes. Chemicals can have local effects, such as damaging the skin, but may also be absorbed into the body and affect other, distant parts of the body (systemic effects).

**The lungs** The job of the lungs is to exchange gases, allowing oxygen to be

absorbed into the blood stream from the air we breathe, and get rid of waste carbon dioxide from the body. In the same way, the lungs will readily absorb other chemicals found in workplace air. As well as gases, solids can reach the lungs when present as small particles suspended in air, such as dusts and fumes. One of our case studies involves fumes from solder flux, and dusts from asbestos, silica, wood, cotton and flour have killed thousands of workers. Some dusts may also cause a particular kind of explosion.

### **Rosin solder flux fume and occupational asthma**

In March 1989, Violette Hutchins got a job as a cable assembler with the electronics firm Huber and Suhner. The company made test units for Harrier jump jets and parts for Hewlett Packard computers, and Violette's work involved soldering electrical connections.

"It was a very good job," she remembers. "It was well paid, interesting and meant I didn't have to work nights or weekends." That was important for Violette, because her husband Brian was a fireman, and when they both worked shifts, they seldom saw each other. She hoped that the new job would allow her to spend more time with Brian and their children, such as going to karate, which they did as a family. Little did she know that the new job would damage her health so badly that she would need to rely on an oxygen cylinder, even to hold a conversation, for the rest of her life.

Violette remembers beginning to feel ill just three months into her new job, in the summer of 1989. "I had what I thought was a cold," she says. "But I couldn't get rid of it. I had a horrific cough, and went to and fro to the doctor. First he said I had hay fever, then 'flu, then hay fever again. Then I had a chest infection."

Just before Christmas, Violette and Brian began to get an idea of what the trouble was. Brian explains, "We went down to my brother's in November, and Vi had an attack which sent her into hospital. It was the doctor there who said he thought she had asthma."

Armed with an inhaler, Violette went back to work but her asthma just got worse. "I could not seem to get back on my feet. The doctors could not find out why it wasn't getting better with the inhalers, but it wasn't. It was just getting worse. I collapsed at work, and was rushed into hospital."

The following year, after four or five spells in hospital, a doctor finally asked her where she worked. Violette remembers, "The attacks were getting very violent and they just came out of the blue." In hospital in Oxford, a chest specialist said, "Out of curiosity, what do you do for a living?" Violette says: "I told him I was a solderer, and he didn't say anything. He walked away and was gone for about half an hour. When he came back he said that he knew what my problem was."

With Violette's permission, the same doctor spoke to her boss, and in June 1992 she was moved from soldering to an office job. But by then the damage was done. She had been sensitised to the rosin flux, and as she had to go into the soldering room to check on drawings, the attacks continued. After a 10-day spell in hospital in June 1992, Suhner's called her in from sick leave to give her the sack.

Violette, a member of the TGWU since her teens, took Suhner's to an industrial tribunal for unfair dismissal, and accepted three months' wages from the company before the tribunal met. However, it was while talking to the union's solicitor about the unfair dismissal, that she discovered she might also have a case for compensation.

The TGWU supported Violette through a five-year battle for compensation for her occupational asthma, and in November 1996, she accepted an out-of-court settlement from Suhner's of £500,000. The case, however, left her almost as exhausted as her industrial disease.

"To be honest, if I'd have known what was going to happen in those five years, I would not even have started it," she admits. "I should never have been made to fight for five years. I'm sure they do it in the hope that you'll either die or run out of money. All I wanted was for them to admit what they had done. I didn't want their money, because I can't buy what I want, I can't buy my health back."

Brian gave up his job in 1994 to look after Violette, who needs 24-hour care. The following year, they asked the court for an interim payment to buy a bungalow, because Violette could no longer climb the stairs. Despite being awarded £50,000, the DSS clawed most of it back. Brian says, "Two hours (after the award was made) the Department of Social Security (DSS) called and said they wanted five years benefit repaid. They took £42,000 and we still couldn't move. We had to put up with the stairs for another 18 months."

"If the government and the DSS had their way, I'd be shut away in this house, because that's all you're supplied with," Violette says, tapping the three-foot tall oxygen cylinder beside her. The electric wheelchair and portable oxygen she needs just to get outside cost £3,000. What Violette did discover during the case, was that Suhner's had made no attempt to protect her, or the 12 others she worked with, from breathing in the solder flux fume. The soldering room was a converted office with no ventilation except the windows. There were no medical checks on the workers, either before or after they started work, and none were given any information on the hazards of rosin. The site was not registered as a factory, so the Health and Safety Executive (HSE) had no reason to think they ought to pay it a visit. But despite all this, the firm was never prosecuted by the HSE.

As Violette explains, "They had been using dangerous chemicals all that time. I should have had a medical before they employed me. They would have found out that there was asthma in the family, and I should have had a medical every six months because of the hazards of the work. We didn't have a company doctor, we didn't have a nurse. We didn't have a rest room. Now they have medicals. It's all changed, they've virtually built a new factory, but there are still 12 people walking around that could still go down with occupational asthma; it can take up to 25 years to develop. I hope they don't because I wouldn't wish it on anybody."

### **The extent of the problem**

Rosin (sometimes called colophony) is a natural product which comes from pine sap. Rosin solder flux fume is a well-known irritant and sensitiser, and is a major cause of occupational asthma. In 1993 doctors from the HSE examined 152 women like Violette Hutchins. They all worked as solderers in medium-sized electronics firms. All were exposed to rosin solder flux fumes because local exhaust ventilation in the factories was inadequate or non-existent. Almost half of the women (49%) had a persistent wheeze or chest tightness, and a quarter (24%) had occupational asthma. The actual numbers are likely to be larger, because many of the women made ill by the fume will have had to give up work. According to the study, "The effects of colophony are well known. The surprise is that we can still discover them so readily" [K. Palmer and G. Crane, Respiratory disease in workers exposed to

colophony solder flux fumes: continuing health concerns, *Occupational Medicine* 1997, 47(8), 491-496].

#### HSE advice

In its publication *Asthma*? the HSE says, "Around 1980, reports of a high prevalence of occupational asthma among solderers in the electronics industry led to the conclusion that there was a significant health problem caused by exposure to rosin-based solder flux fume." In its leaflet for employers, *Controlling health risks from rosin-based solder fluxes*, the HSE says rosin fume "is one of the most significant causes of occupational asthma in the UK."

Once asthma has developed, even small exposures to fume can lead to asthma attacks. When fully developed, the condition is irreversible. The fumes can also irritate the upper respiratory tract, eyes, and skin. Early symptoms of exposure are watery and prickly eyes, a runny or blocked nose, sore throat, cough, wheezing, tight chestedness and breathlessness.

**The skin** Although the skin acts as a protective barrier against many micro-organisms and chemicals, some chemicals can penetrate the skin and enter the blood stream. Whether or not a chemical is absorbed through the skin depends on its structure: chemicals need to be able to dissolve in both water and fat (lipids) to get through the skin. Those that are insoluble, or dissolve only in fats or water, and chemicals made up of very large molecules, tend not to penetrate the skin. Chemicals are more easily absorbed where the skin is thin, such as on the forearms, than through the thick skin covering the palms of the hands and soles of the feet. Chemicals are also more easily absorbed if skin is moist or damaged. Some chemicals, e.g. organic solvents, cause 'defatting' of the skin, making it a less effective barrier against further chemical exposure.

Methyl ethyl ketone (MEK), the organic solvent used by Tony Bradshaw (see p 20), is rapidly absorbed through the skin. In a study using human volunteers, MEK was applied to the skin of their forearms, and could be detected in the air they breathed out just three minutes later. During that time, the MEK had made its way through the skin, into the blood, and then to the lungs. Because MEK is soluble in water, it is absorbed through the skin even faster if the skin is sweaty. However, the amount of MEK in exhaled air accounted for only 10% of the amount applied to their skin. The

other 90% was excreted in the urine, both as MEK and as its metabolites (*Environmental health criteria 143 methyl ethyl ketone*, WHO, 1993).

**Ingestion** As well as the lungs and skin, chemicals can also enter the body if swallowed. In the workplace, this can occur if areas used to eat, drink or smoke are contaminated with chemicals, or if workers do not wash their hands or remove their gloves before eating or smoking.

## **Transportation, storage, metabolism and excretion**

**Transportation** Once absorbed into the blood, the chemical is carried around the body in the blood stream, and where it ends up is influenced by its structure and properties. However, some barriers exist in the body which can keep out some (but not other) chemicals, such as the blood-brain barrier which helps protect the brain, and the placenta which helps protect a foetus.

**Storage** Inside the body, some chemicals are stored in certain tissues, such as fat or bone, and while they remain bound up there, they may do little damage. However, under certain conditions such as rapid weight loss, large amounts of the chemical are released into the blood. How long such chemicals remain in the body varies, but some, like the pesticide DDT, remain for years. One of the reasons why DDT stopped being used in the developed world was because of this persistence in the environment, and even though it has not been used for years in the developed world, most of us have DDT in our bodies.

**Metabolism** If chemicals are not stored, the body deals with them by metabolising (changing their structure) and excreting them. This occurs mainly in the liver, but also the skin, lungs, gut and kidneys, by similar processes used by our bodies to metabolise the chemicals which make up our food. The products of metabolism are known as metabolites, and these can be more or less toxic than the original chemical. In fact, many of the adverse effects of chemical exposure are due to the effects of metabolites.

The pathways involved in metabolising chemicals vary greatly between species, and also between individuals, which explains why some people are harmed by very low levels of chemicals that others seem able to tolerate.

**Excretion and biological monitoring** Chemicals and their metabolites are excreted from the body, mainly via urine produced by the kidneys. Small amounts are also excreted by the lungs, and in sweat, semen, milk, saliva and bile. The amount of a chemical a worker has been exposed to can sometimes be estimated by measuring how much of the chemical, or certain metabolites, is found in urine. This is known as biological monitoring.

## **Toxic effects**

We need to look more at what happens when chemicals enter the body and at the range of effects they might have. Toxicologists often quote a 16th Century Swiss doctor, Paracelsus, to illustrate that it is incorrect to divide chemicals into those which are toxic, and those which are not. Paracelsus said, "All substances are poisons; there is none which is not a poison. The right dose differentiates a poison and a remedy." Certain substances, including some naturally occurring plant and animal poisons, are lethal at tiny doses. Others, such as some of the things we eat, drink, or work with, can be lethal but only in massive quantities.

## **Acute and chronic exposure**

As well as the dose of a chemical, its toxicity also depends on how long exposure lasts, the duration of exposure. This duration is one way that the toxicity of a chemical can be categorised. Single exposures are referred to as acute exposure, and repeated exposure over a longer time as chronic exposure. Duration of exposure should be reported with toxicity data in safety data sheets, etc. The other way toxicity is categorised is according to the chemical's target, the organ or body system which it damages.

The terms 'acute' and 'chronic' are also used to describe how long it takes for the effect of a chemical to occur, and it is important to be aware of these two uses. An acute effect is one which happens immediately on exposure, whereas a chronic effect does not. It may take years to appear. The time between exposure and the onset of disease is referred to as the latency period. Because there is such a long latency between certain chemical exposures and diseases such as cancer, it is often difficult to link them to occupational exposures. This is one reason why workers should insist that the chemicals they work with are recorded on their medical records.

These two uses of the terms 'acute' and 'chronic' are not connected in the sense that an acute exposure only leads to an acute effect. In fact, an acute exposure can lead to either an acute or a chronic effect.

When talking about toxicity, the easiest way to divide chemicals is by the organ or system they damage. These target organs or systems are often referred to in safety data sheets and toxicology books. The commonest are: the lungs, the skin, the gut, the liver, the kidneys, the nervous system, the blood, the cardiovascular system, the immune system, and the reproductive system. There are even chemicals which can affect hearing.

Chemicals causing liver damage are sometimes called 'hepatotoxins', those which damage the kidneys 'renal toxins', and those harming the nervous system 'neurotoxins'. Chemicals that cause cancer, although they may affect either one or several organs, are lumped together and described as 'carcinogens'. Those that cause birth defects are called 'teratogens'.

"A toxin is generally understood to be a substance that is harmful to biological systems, but within this simple concept lies a great deal of variability. A substance that is harmful at a high dose may be innocuous or even essential at a lower dose. A toxin may damage a specific body system, or it may exert a general effect on an organism. A substance that is toxic to one species may not be toxic to another because of different metabolic pathways or protective mechanisms. And the biologic damage may be temporary, permanent over the organism's lifetime, or expressed over subsequent generations" (H. Frumkin in Levy and Wegman).

## Respiratory system

The respiratory system includes the nose and the tubes leading to the lungs (the trachea and bronchi), as well as the lungs themselves. Because their job is to exchange gases, the lungs are vulnerable to chemicals both in the form of small particles, and as gases, vapours and mists. The lungs have a surface area of about 500 square feet (Rodricks) and come into contact with 20 kg of air each day (Stacey). Chemicals can cause a variety of damage to the lungs, including irritation, structural changes such as fibrosis, and cancer.

**Irritation** Many chemicals irritate the lungs, such as ammonia, chlorine, hydrogen chloride and sulphur dioxide gases. The respiratory system responds to these irritants by tightening the bronchi, which results in a feeling of tight-chestedness. This is sometimes referred to as 'dyspnoea' in safety data sheets. If the irritation is very severe, cells can be damaged and fluid released (oedema). Such damage can make the lungs more vulnerable to infection.

**Emphysema and fibrosis** Chronic exposure to some chemicals, such as certain forms of some metals, can cause structural changes in the lungs like emphysema. Dusts can also produce a particular type of lung damage called fibrosis. Some dusts, like crystalline silica, cause cells in the lungs to produce fibrous materials which can build up, making the lung rigid and unable to work properly. Asbestos also causes a kind of fibrosis, known as asbestosis, as well as mesothelioma and lung cancer. As well as asbestos, other

chemicals that cause lung cancer include: radon, arsenic, some forms of chromium, nickel, cadmium, bischloromethyl ether (BCME), beryllium, soot and environmental tobacco smoke.

**Asphyxia** Some gases, like methane and nitrogen, although they have little effect on the body itself, can displace oxygen in air and cause suffocation or asphyxia. Other chemicals like carbon monoxide work like this but on a cellular level, where they stop cells taking up or using oxygen in the blood.

**Asthma** Other chemicals, like colophony, cause allergic reactions in the respiratory system, including occupational asthma. Occupational asthma is the most commonly reported occupational disease according to SWORD, the UK respiratory disease monitoring scheme.

### Occupational asthma

In 1995, a National Asthma Campaign telephone survey of over 300 small and medium-sized businesses found 59% did not know what occupational asthma was, 62% of firms who understood the condition had done nothing to control the hazards, and 81% had taken no action to control exposure to occupational asthmagens.

In a study of 100 patients of Birmingham Heartlands Hospital's occupational lung disease unit, 91% said they had never been informed about the risks of getting asthma at work, and 73% had never seen a safety data sheet. Most worked in the car industry, hospitals, foundries or with wood. Many worked with chemicals well known to cause asthma, such as isocyanates, colophony and wood dust. Although almost half worked for firms which had an occupational health service, less than one-third had pre-employment screening. The results of this study paint a very different picture of COSHH compliance compared with the HSE's 1991-92 evaluation survey which found 80% of employers provided workers with adequate information and training. The Birmingham study said, "There were only modest improvements after the introduction of COSHH" [S. Siriruttanapruk and P. S. Burge, The impact of the COSHH regulations on workers with occupational asthma, *Occupational Medicine* 1997, 47(2), 101-104; COSHH - the HSE's 1991/92 evaluation survey *Occupational Health Rev.*, 1993, 44, 10-15].

### The cost of occupational asthma

According to the Labour Force Survey, 70,000 people say that their

work either caused their asthma, or made it worse. Over 1,000 new cases of occupational asthma are reported to the UK's Surveillance of Work-related and Occupational Respiratory Diseases (SWORD) scheme each year. SWORD was set up in 1989, funded by the HSE, and pools data from chest clinics and occupational physicians.

This is likely to be a significant underestimate and TUC figures suggest that up to 400,000 people suffer from asthma because of their work. Occupational asthma causes over a million days' sick leave each year, four times as many in 1994 as were lost in strikes. The TUC says there should be a national asthma register, an extension of the official definition of occupational asthma to cover irritants, an Acop to bolster existing laws, better compensation, and a licensing system for manufacturers of chemicals that cause asthma (*Hazards at work: TUC guide to health and safety*, TUC, 1997; Rory O'Neill, *Asthma at work: causes, effects and what to do about them*, TUC/Sheffield Occupational Health Project, 1995).

## Skin

The skin is the largest organ of the body, covering about 9 m<sup>2</sup>, the size of a tennis court. Skin effects are much more obvious than damage to other organs, and in the USA, for example, skin diseases account for a third of all reported occupational diseases (Levy and Wegman).

Occupational skin diseases can be classified into several types, or reaction patterns: contact dermatitis (irritant contact dermatitis and allergic contact dermatitis), urticaria, follicle abnormalities, infections, pigment disorders, and neoplasms.

**Dermatitis** Contact dermatitis is the most common occupational skin reaction. In the UK, it accounts for 80% of the cases reported to EPI-DERM, the skin disease monitoring scheme. Dermatitis is an inflammation reaction, where the area which comes into contact with the chemical becomes red, swollen or blistered, and feels itchy or burning. It can be caused by irritants or result from an allergic reaction. The HSE says: "At worst, contact dermatitis can be as disabling at work as the loss of a limb." The HSE estimates 132,000 working days are lost every year because of occupational dermatitis, and many people are forced to change jobs as a result (*Toxic Substances Bulletin* 1996, 31, pp. 1-2, 7).

Irritant contact dermatitis can be caused by many substances. Some, like

soaps, detergents and many solvents, are mild irritants to which the skin needs to be exposed in large amounts or for long periods to cause dermatitis. Others are very strong irritants, such as hydrogen fluoride and sulphuric acid (both strong acids), or sodium hydroxide (a strong alkali). These chemicals cause what are sometimes called 'chemical burns', destroying the skin and causing ulcers and scarring. Irritant contact dermatitis is much more successfully treated if detected early.

Allergic contact dermatitis results from a specific allergy, where an individual is sensitised by an initial exposure, and then reacts when re-exposed to even small amounts. Chemicals which often cause allergic contact dermatitis are: latex (in surgical gloves), formaldehyde, rubber additives, nickel or chromium compounds, bactericides and fungicides, adhesives and sealants, plants and wood, and hairdressing chemicals. Because people vary in their susceptibility to substances that can cause allergic contact dermatitis, it may occur in only a few people in a workplace. Just because only one or two people are affected does not mean it is not work-related.

**Chloracne** Some chemicals like creosote, oils and greases can make existing acne worse, especially affecting skin beneath clothing which is saturated with the oils. Other chemicals cause a specific type of acne called 'chloracne'. Chloracne is small straw-coloured cysts and inflamed follicles, often behind the ears and at the outer corner of the eyes. It is caused by chlorinated hydrocarbons, found in herbicide manufacturing and cable splicing, and by polychlorinated biphenyls. As well as its effect on the skin, chloracne should be treated as evidence that these chemicals have been absorbed into the body through the skin.

**Pigment changes** Although changes in skin pigmentation can be due to any skin injury, particular kinds of pigment loss can be caused by chemical exposure. One such is the monobenzyl ether of hydroquinone, an antioxidant used in rubber manufacture.

**Skin cancer** The final, and most potentially serious, kinds of skin disease are neoplasms (growths). These may be benign or cancerous. Discovery of skin cancer of the scrotums of chimney sweeps in London in 1775 by Sir Percival Potts was the first recorded case of occupational cancer.

## Nervous system

The nervous system is usually described in two parts, the central nervous system or CNS (brain and spinal cord), and the peripheral nervous system (the other nerves which control the muscles and senses). Chemicals may affect the CNS or the peripheral nervous system or both.

### Solvents and brain damage

Tony Bradshaw is 60. Although he is still a few years away from the official male retirement age, he has not worked since he was 47. He was retired on grounds of ill-health from the Ministry of Defence (MoD) in 1986, after being told he had cerebellar ataxia (CA). The part of his brain which controls balance, the cerebellum, had been damaged. This explained why Tony staggers, has problems signing his name, and has to get his wife Sheila to tie his shoe laces.

When he was diagnosed, the doctor told him that several things cause cerebellar ataxia. It may be inherited, can be caused by viruses, but could also be the result of exposure to chemicals. Tony remembers, "I was devastated, but I was so upset by my condition that I made no connection between it and my work."

A year afterwards, several chance events made Tony wonder if his ataxia might have been caused by his job. The first was meeting fellow CA sufferers through a self-help group that Tony set up. They held regular meetings, but Tony says he always felt the odd one out. The pattern of his condition just did not match any of the others.

The second event occurred when he and Sheila took a trip to the Cotswolds just before he retired. Tony remembers, "We visited somewhere where railway engines were being renovated, and we saw a big drum that said 'MEK' on the side, and there was a big warning label on it." In all the years that Tony worked with MEK (methyl ethyl ketone) he had never seen such a label. He used MEK, an organic solvent, to clean up the Seacat missiles he worked on, but nobody had ever told him it was a health hazard.

Tony went off to see a local solicitor, when the whole story began to emerge. After a six year battle, supported by his union, the AEEU, Tony accepted an out of court settlement from the MoD of £280,000.

"We only started this as a matter of principle," he says. "People went into the services expecting to be looked after – it was a large employer, not a back street garage that takes short cuts... Something had happened to us that I did not want to happen to anybody else. I worked all my life and expected to retire in good health at 65. I never expected to come out at 47. You leave home in good health, you go to work, and you expect to come home in good health. What made me angry was that they would let something happen to you along the way."

From what Tony remembered during the six-year case, much had gone wrong along the way which had exposed him to very high levels of MEK. Exposures which, had they been prevented as the law requires, would have meant Tony might now be looking forward to a healthy retirement.

Tony used a rag soaked in MEK to clean parts of the Seacat missiles before he put them back together. "My wife collected old Marvel dried milk cans for me to store the MEK in. It had a vile vapour and we used to mark the tins 'MEK – smelly stuff'."

He was never given gloves or a mask, and doors of the small room he worked in, E302, were supposed to be kept shut. "E302 had a fan on the wall which sounded like a helicopter. It was beside the explosive maintenance assistants and was so noisy that it would annoy them and they would turn it off."

Missiles are expensive and dangerous weapons, and the MoD had rules about how many Seacats were allowed in E302 at any time, and also about how many hours a day fitters could work on them. The temperature and humidity in E302 were checked daily, in case they affected the missiles. But when Tony complained about the MEK, he was ignored. "They didn't seem to bother about health and safety, they just wanted to know about production figures," he says.

Looking back on it, Tony says he first noticed something wrong with his health in late 1982. "I began to be aware of difficulties holding a pen and writing, but put this down to getting older and tried to ignore it ... In late 1983, signing for my work became so difficult that I made up my own little rubber stamp to save myself from having to write," he says. He would get work mates to sign any birthday or leaving cards that came round, making excuses that his hands were dirty. "Now that we've had time to look back, all these things finally fall into place," Sheila says.

Finally, when he went to the works doctor about backache, he could no longer pretend that all was well. "I had run out of excuses, I couldn't make any more. I was tired of making excuses," he says. After first accusing Tony of being drunk on duty, the doctor sent him for tests. "Within the week, I was never to work again," Tony says.

There are many things Tony has been unable to do since then. A very inquisitive and practical man, both he and Sheila are proud of how few

times they had to rely on someone else to fix the house or the car. "Over my life, I've been to the garage about three times with the car," he says. "I used to do all these things. Most people my age spent their life with 'make do and mend' – if something broke, you would fix it yourself."

He now relies on Sheila, and has even talked her through changing the pump on their central heating system. They laugh when they remember the episode. "There was water everywhere," he says, "but we got there in the end... if you don't have a little laugh about it, you go under."

Even though Tony and Sheila still laugh, and the compensation has removed some of their worries, Tony says, "No money in the world can make up for me not being able to do my own DIY or get underneath the car. Most of all, I would like my health back."

### **Solvents at work**

Industrial solvents are targeted in phase three of the Health and Safety Executive's *Good Health is Good Business* campaign. The HSE says about 1400 kilotonnes of solvents were used in the UK during 1995. More than 7 million workers are exposed to industrial solvents, over 2 million of whom are regularly exposed; most of these work for firms employing less than 50 people, those least likely to be aware of COSHH. There are hundreds of different types of solvents, many of which cause ill-health unless exposure is controlled. High-risk industries and processes include chemicals manufacture, printing, paint manufacture, pesticide manufacture, edible oil extraction, pharmaceuticals manufacture, rubber manufacture, painting, dry cleaning, and degreasing. Pressure for substitution of certain organic solvents for environmental reasons is greater than concern for workers' health (*Good Health is Good Business: employers' guide*, HSE, 1998; *Toxic Substances Bulletin*, May 1997, 33).

**The peripheral nervous system** Chemicals that damage the peripheral nervous system do so in one or both of two ways. Chemicals can damage the outer covering of the nerve (the myelin sheath), which can re-grow quite quickly, or the nerve (axon) itself. Axons can regenerate, but only slowly. The solvents n-hexane and methyl butyl ketone (or more precisely, their metabolite hexane-2,5-dione) are examples of chemicals which damages axons. n-Hexane has been used in paints, glues, varnishes, plastics and rubber and its effects on the peripheral nervous system have been reported in shoe makers and cabinet makers (Stacey).

Damage to the peripheral nervous system causes symptoms like pins and needles (parasthesia), numbness and weakness in the hands and feet. The onset of these symptoms can be delayed for several months. Although many chemicals which affect the peripheral nervous system cause very similar effects, some produce more specific symptoms. Arsenic, for example, causes painful limbs and sensitive feet. Trichloroethylene, an organic solvent, affects nerves in the face, causing facial numbness and weakness, while the insecticide chlordecone (also known as Kepone) causes abnormal eye movements. Recovery from peripheral nervous system damage depends on the chemical involved, and the intensity of the exposure (Levy and Wegman).

**The central nervous system** Chemicals that affect the CNS often do so by interfering with neurotransmitters (the chemicals needed to transmit nerve impulses). Examples are metals like lead and mercury, organophosphate pesticides and organic solvents (Table 2). Lead and mercury do not just affect the nervous system, but also affect the kidney and gut. Mercury also affects the lungs and lead affects the reproductive system. These effects are important not only because of their nature, but also because so many workers are exposed to lead and organic solvents.

**Table 2: Neurotoxic effects of certain chemicals**

lead	tiredness, irritability, difficulty in concentrating
organophosphates	blurred vision, tight chest, stomach cramps, nausea and vomiting
organic solvents	appearance of being drunk, drowsiness (narcosis), tiredness, irritability, difficulty in concentrating, memory loss, dementia

The type of effects, and whether they are likely to improve or persist, depend on the degree and duration of exposure to a chemical. In the case of organic solvents, the World Health Organisation divides the effects of exposure into three groups, according to their severity: Type 1, organic affective syndrome, leading to irritability, tiredness, difficulty in concentrating; Type 2, mild chronic toxic encephalopathy producing Type 1 effects, but more pronounced; and Type 3, severe chronic toxic encephalopathy, resulting in memory loss and dementia.

## **The liver**

As well as storing vitamins and iron, regulating blood sugar levels and its role in digestion, the liver metabolises foreign chemicals. Metabolism sometimes results in a chemical being changed into a more toxic metabolite, and this is one way in which chemicals can damage the liver.

As with other organs, liver toxins can be grouped together according to the kind of liver disease they cause, including acute hepatitis (inflammation of the liver) or chronic diseases like cirrhosis and cancer. These diseases can also be caused by viruses such as hepatitis B, an important risk for health care workers, as well as non-occupational factors.

Chemicals that cause acute hepatitis include carbon tetrachloride, chloroform, dinitrophenol, dinitrobenzene, dioxin, polychlorobiphenyls, the pesticide DDT, chlordecone, chlorobenzenes, the anaesthetic halothane, the dye feedstock methylenedianiline and the explosive TNT. Symptoms of acute hepatitis include headache, nausea, vomiting, dizziness and drowsiness. As well as alcohol, cirrhosis is also caused by arsenic and vinyl chloride. Vinyl chloride is well known for causing liver angiosarcoma, a rare kind of cancer. After clusters of cases were reported in the 1970s, studies were done in vinyl chloride plants which found high levels of this liver cancer. Vinyl chloride is metabolised in the liver to an epoxide that causes the cancer. As well as a Maximum Exposure Limit, a yearly exposure limit of 3 ppm applies to exposed workers.

High levels of chronic liver disease have been reported in refrigeration engineers, chemists, dry cleaners, rubber manufacturers, and workers exposed to carbon tetrachloride and plutonium (Levy and Wegman).

## **The kidney and urinary tract**

Proven or suspected kidney toxins (nephrotoxins) include arsenic, beryllium, lead, cadmium, mercury and uranium plus their compounds, solvents, and pesticides. Kidney failure from exposure to lead was common earlier this century, and kidney disease is the best known effect of chronic exposure to cadmium.

The kidneys, via urine, are the major route by which toxic chemicals are excreted from the body. Because of this, and the way the kidneys do their job, they are vulnerable to the toxic effects of chemicals. The damage caused is complicated, and in many cases still not well understood, but can result from acute and chronic exposure.

According to the US National Bladder Cancer Study, up to a quarter of bladder cancers are caused by work. Aromatic amines are one group of chemicals known to cause bladder cancer. Occupationally-induced bladder cancer was first reported in 1895 in German dye-manufacturing workers. Because they use dyes, jobs where workers are at risk of developing bladder cancer include textile, fur and leather dyeing as well as aromatic amine manufacturing. Aromatic amines are also used in rubber and plastics manufacture. Even though bladder cancer usually takes around 20 years to develop after exposure to aromatic amines, this can range from 4–40 years, and can result from exposures as short as 19 weeks (Levy and Wegman).

MBOCA is one aromatic amine used as a stabiliser in plastics manufacturing, often by small manufacturing plants. After an HSE national enforcement project in 1996–97, the HSE described conditions in many of these workplaces as “rough and ready.” MBOCA is easily absorbed through the skin, and in many of these small factories even the eating areas and maintenance workers’ tools were contaminated (M Piney et al., MBOCA – Toxicology, exposure and control, Occupational Hygiene ’98 abstracts, BOHS, 1998)

## **Blood**

Chemicals which affect the blood can do so either by being directly toxic to blood cells, or by preventing it from delivering oxygen to the rest of the body. Haemoglobin is the molecule which carries oxygen to the body’s tissues, and by combining with it to form carboxyhaemoglobin, carbon monoxide prevents oxygen reaching the tissues. Carbon monoxide is produced when organic substances such as gas and petrol are incompletely burnt, and as it is present in car exhausts, fire fighters, garage workers and traffic police can be exposed to high concentrations. Carbon monoxide is also produced by poorly maintained gas fires, and can also be produced in the body by metabolism of some chemicals like methylene chloride. Blood carboxyhaemoglobin levels are around 0.5% in non-smokers, and 5% in smokers. Headaches occur at levels of 10–20%, and a level of 60–70% is fatal within hours.

Other substances combine with haemoglobin to form methaemoglobin, which is also unable to deliver oxygen to the tissues. Workplace chemicals which have this effect include aniline dyes, nitrous gases, potassium chlorate, nitrobenzenes, phenylenediamine, and toluenediamine. Methaemoglobinaemia also results from environmental exposures to foods high in nitrates or nitrites, or well water contaminated with nitrates (Levy

and Wegman). As well as binding with red blood cells to interfere with the carriage of oxygen, other chemicals can break up red blood cells. This is known as haemolysis, and is caused by chemicals like naphthalene, copper, organic compounds of metals such as tributyltin, and arsine.

Arsine gas is an inorganic arsenic compound, and although it is used in the electronics industry, it is most dangerous because it can be formed accidentally when arsenic-contaminated metals or coal come into contact with acids. There have been cases of sewer workers being gassed by arsine after using acids to clear drains previously contaminated with substances containing arsenic. As well as its effects on red blood cells, arsine also causes kidney failure.

Lead also affects the blood by interfering with red blood cell manufacture. These cells are produced in lower quantities and do not live as long as normal, causing anaemia. Workers exposed to lead, such as welders, painters, jewellers, and in smelters, foundries and potteries, are covered by special legislation in the UK and should have biological monitoring to assess their exposure.

Benzene is another well known example of a chemical which causes blood toxicity. It is metabolised in the body to a chemical which damages bone marrow, the site where blood cells are produced. Leukaemia, a form of cancer, was first linked with exposure to benzene in the 1920s. It also causes aplastic anaemia which, like leukaemia, is often fatal.

## **The heart and blood vessels**

Much less work has been done on occupational, as opposed to hereditary or lifestyle, factors associated with heart disease. However, because heart disease is the largest cause of death among both men and women in the UK, even a small reduction in risk due to occupational exposure could involve large numbers of people, and be an important public health measure. There is good evidence that occupational exposure to certain materials, such as the solvent carbon disulphide, is linked with heart disease.

Explosives manufacturing workers exposed to nitroglycerin and ethylene glycol dinitrate can suffer from angina when away from work, because these chemicals (like those used to treat angina) cause the heart's blood vessels to expand. Acute exposure to some solvents has also been associated with sudden death, probably due to changes in the heart's rhythm.

## The reproductive system

Reproductive hazards can be divided into two groups, those which cause reproductive effects, such as chemicals which impair sperm production and fertility, and those which damage the developing foetus. Reproductive hazards affect both men and women at work.

Several chemicals are known to make men less fertile by affecting the production of sperm. Other substances can reduce sex drive or cause impotence. In women, some occupational exposures are associated with irregular periods, increased rates of miscarriage, or premature or low birth weight babies (which are less healthy and more likely to die before their first birthday than other babies), or deformed babies. Chemicals that cause birth defects are known as teratogens, and the effects they have as 'teratogenic'. These can include visible (structural) deformities or functional abnormalities, like learning difficulties.

As well as the dose a woman is exposed to, the stage of her pregnancy at which the exposure takes place is important. The developing foetus is very vulnerable to teratogens during the first three months of pregnancy, precisely the time when a woman may not realise she is pregnant. Because of this, reproductive hazards at work should be identified before women become pregnant.

Only about 4% of the chemicals in commercial use in the USA have been tested for teratogenicity. But of those tested on animals 37% are clearly, probably or possibly teratogenic (Stacey p.109).

Reproductive effects have been reported in many occupational groups, including health care workers, laboratory and dental technicians, factory workers, pulp and paper industry workers, construction workers, transport and communication workers, printers, plastics industry workers, and lead production workers.

**Table 3: Male reproductive hazards reported in human and animal studies**

effect	in men exposed to	in animals* exposed to
Impotence or low sex drive	metals (lead, manganese, mercury), toluene di-isocyanate, vinyl chloride, chloroprene	

testicle damage or infertility	pesticides [Kepone, dibromochloropropane (DBCP)], chloroprene, lead	benzene, benzopyrene, boron, cadmium, epichlorohydrin, ethylene dibromide, polybrominated biphenyls
toxicity to sperm	pesticides (carbaryl, DBCP), carbon disulphide, lead, radiation, heat stress, toluenediamine + dinitrotoluene, cytotoxic drugs	arsenic, chloroprene, ethylene glycol ethers, ethylene oxide, halothane, Kepone, mercury, nitrous oxide, trichloroethylene, triethyleneamine

\* The considerable variation in reproductive and developmental toxicity in different species makes it difficult to apply the results of animal tests to humans.

### **Reproductive hazards in women reported in human and animal studies**

<b>effect</b>	<b>in women exposed to</b>	<b>in animals exposed to</b>
irregular periods and other gynaecological disorders	aniline, benzene, chloroprene, formaldehyde, inorganic mercury, polychlorinated biphenyls (PCBs), styrene, toluene	
abortion or infertility	anaesthetic gases, aniline, arsenic, benzene, ethylene oxide, cytotoxic drugs, ethylene oxide, formaldehyde, lead, 2,4,5-trichlorophenol	
foetal toxicity or death		chloroform, dichloromethane, ethylene dichloride, inorganic mercury, nitrogen dioxide,

		polybrominated biphenyls, selenium, tetrachloroethylene, thallium, trichloroethylene, vinylidene chloride
low birth weight	carbon monoxide, formaldehyde, PCBs, toluene, vinyl chloride	
premature birth	lead, heat stress	
teratogenicity	hexachloroprene, radiation, organic mercury, vinyl chloride	arsenic, benzopyrene, chlorodifluoromethane, chloroprene, monomethyl formamide, acrylonitrile, methyl ethyl ketone, tellurium
cancer	diethylstilboestrol (DES), hepatitis B	arsenic, benzopyrene, vinyl chloride

In the UK and the rest of Europe, safety data sheets and labels should contain information on reproductive hazards, including the risk phrases “R46 (may cause heritable genetic damage)”, “R61 (may cause harm to the unborn child)”, “R63 (possible risk of harm to the unborn child)” and “R64 (may cause harm to breast-fed babies)” required by the CHIP Regulations (see pp 63-64).

The results of two large studies on rates of miscarriage (spontaneous abortion) were published in 1997. One, funded by the HSE, looked at dry cleaning workers in the UK. The other examined all previously published research on women exposed to anaesthetic gases at work. Although perchloroethylene has been used as an industrial solvent for over 50 years, and in dry cleaning for more than 30 years, concern over its effects on pregnant women arose after a Finnish study in 1980 which found dry cleaning workers twice as likely to miscarry as other women. The UK study looked at 7305 women who worked in dry cleaners, and found they were half as likely again as other women to report that they had a miscarriage (P. Doyle et al., Spontaneous abortion in dry cleaning workers potentially exposed to perchloroethylene, *Occupational and Environmental Medicine*,

1997, 54, 848–853). A similarly increased risk of miscarriage was found for women exposed to anaesthetic gases (J.-F. Boivin, Risk of spontaneous abortion in women occupationally exposed to anaesthetic gases: a meta-analysis, *Occupational and Environmental Medicine* 1997, 54, 541–548).

## Cancer

Several carcinogens (cancer-causing agents) have already been mentioned. However, it is more usual to discuss cancer-causing chemicals together as a group, irrespective of which organs or systems they affect.

Cancer is not one, but dozens of diseases affecting different organs and tissues. Cancer kills over one in five of the population of industrialised countries, due to both inherited and environmental (including diet and lifestyle) factors as well as workplace exposures.

How much cancer results from workplace exposures has been argued about for years. In 1978, scientists from the US National Cancer Institute, National Institute of Occupational Safety and Health, and National Institute of Environmental Health Sciences estimated 20–40% of cancers were work-related (M Firth et al.). Two UK scientists, Richard Doll and Julian Peto, said in 1981 that only 2–8% of all cancers were due to work. These figures have been debated ever since, with arguments from a variety of standpoints (Hazards 54).

A 1996 review of occupational lung cancers said that 9,000–10,000 men and 900–1,900 women develop lung cancer each year in the USA due to past occupational exposure to carcinogens. This represents 9% of male and 2% of female US lung cancer cases. Others say that 17% of US male lung cancers stem from exposure to carcinogens at work (K Steenland et al., Review of occupational lung carcinogens, *American Journal of Industrial Medicine* 1996, 29, 474–490).

Cancers are complex diseases, because they usually result from several factors, and often take many years to develop. There are also several different steps involved in the process which turns normal cells into cancerous tumours. As a result, carcinogenesis (the development of cancer) is described as a multi-step process. The two most important stages are initiation and promotion. Some chemicals or their metabolites act as initiators, causing permanent changes in a cell's genetic makeup (mutation). Others will then promote the development of these abnormal cells into a tumour. Some chemicals act as both initiator and promoter. However, not all chemicals that cause mutations (mutagens) are carcinogens, and some chemicals cause cancer without damaging DNA.

**Synergism** The risk of developing lung cancer due to smoking and/or exposure to asbestos is a useful example of synergy, which occurs when the combined effect of two chemicals is much greater than their additive effects. Smokers have a ten-times greater risk of dying from lung cancer than non-smokers, and if people are exposed to asbestos, they are five times more likely to die of lung cancer compared with those not exposed to asbestos. However, the combined risk of dying of lung cancer in a smoker also exposed to asbestos is not 15 times greater than a non-smoker not exposed to asbestos, but 80 times greater.

Testing chemicals for their carcinogenicity is expensive, but two organisations which conduct a lot of carcinogenicity testing are the National Toxicology Program (NTP), part of the US government National Institutes of Health, and the International Agency for Research on Cancer (IARC), part of the World Health Organisation.

Since 1972, IARC has published over 70 monographs reviewing the scientific evidence for carcinogenicity of individual chemicals, as well as mixtures and specific occupations. By 1998, about 834 chemicals, groups of chemicals, complex mixtures, and occupational exposures had been evaluated. Of these, IARC says 75 are carcinogenic to humans (group 1), 59 are probably carcinogenic to humans (group 2A), 225 are possibly carcinogenic to humans (group 2B), and the rest are unclassifiable (group 3). IARC classifications are based on the strength of the scientific evidence, not the potency of the carcinogen.

“Keep in mind that a chemical can be demonstrated to be a human carcinogen only if an opportunity exists to study it in exposed humans in a systematic way, and such opportunities are not frequently found” (J. V. Rodricks).

“Occupational cancer differs from other occupational diseases in several ways: no safe level of exposure to carcinogens is recognised; many different forms of cancer exist; cancer develops many years after exposure; occupational cancer generally resembles cancer of non-occupational origin; and competing carcinogenic exposures are present in many cases. On the other hand, occupational cancer shares at least important features with other occupational diseases: there are large data gaps in relating exposure to disease; and most cases are preventable” (H. Frumkin in Levy and Wegman).

## **The immune system, allergies and sensitisation**

The body's defence against foreign substances and organisms is known as the immune system, and immune reactions play an important part in many work-related diseases. The immune system is complex and relies on the work of many different types of cells which are found in bone marrow, thymus, spleen, lymph nodes, in the lining of the gut and respiratory tract, and in the skin.

The action of some cells is very general, but others respond to specific substances. One of the hallmarks of this specific immunity is that "memory" develops, so that when the body comes into contact with the same substance a second time the response is faster and stronger. Specific immunity is divided into antibody-mediated and cell-mediated systems, and substances that can cause immune responses are called antigens; many of them are proteins.

Hypersensitivity or allergic reactions can be classified into four distinct types: Type I, anaphylactic or immediate hypersensitivity reactions in which symptoms occur within minutes of exposure, Type II, cytotoxic reactions in which symptoms appear within hours, Type III, immune complex reaction, and Type IV, cellular immunity or delayed-type hypersensitivity in which symptoms develop 24–48 hours after exposure.

The most common allergies at work affect the skin and respiratory tract. Common causes of allergic contact dermatitis include latex (in surgical gloves), formaldehyde, rubber additives, nickel or chromium compounds, bactericides and fungicides, adhesives and sealants, plants and wood, and hairdressing chemicals.

Common causes of allergic asthma and rhinitis include latex, flour, mites, enzymes, di-isocyanates, metals and metal compounds, and certain drugs.

## **Multiple chemical sensitivity**

Multiple chemical sensitivity (MCS) is the name given to a very wide range of symptoms, related to a large number of chemicals. MCS has been called by various names, including "environmental illness" and, most recently, "toxicant-induced loss of tolerance" (TILT). MCS has been much talked about since the 1980s but research so far has not yet uncovered the underlying mechanisms.

Some doctors believe that the symptoms of MCS sufferers are "all in the head." This is a view which is far from helpful for patients. Dr Joseph LaDou, Professor of Occupational Medicine at the University of California

says, "Although the aetiology of MCS is controversial, the patient may be suffering from disabling symptoms, frustrated by the lack of definitive answers from clinicians, and is sometimes desperately seeking advice and counsel regarding treatment. Approaching the history with the suspicion that the patient with MCS is suffering from a psychiatric disorder, is malingering, or seeking monetary benefits is not helpful."

Although a psychological cause for MCS has not been ruled out, evidence from most research on MCS points to a physical cause or causes. What puzzles doctors, and frustrates sufferers, is that the symptoms vary widely between individuals, and the substances associated with it are also numerous. Although there are several definitions, most agree that MCS affects one or many organ systems, symptoms come and go, and symptoms are brought on by very low exposures to many different chemicals.

Although they vary a great deal, the symptoms of MCS often involve the upper respiratory tract (blocked nose, dryness or burning), central nervous system (problems with memory or concentration, insomnia, drowsiness, irritability or depression), and gut, as well as muscle or joint pain, headaches and tiredness. These symptoms are triggered by low-level exposure to a large range of substances, but the initial cause will usually have been exposure to one of a smaller number of initiators. In other words, MCS is a two-stage process, involving initiation and triggering.

#### **Table 4: Initiators and triggers of MCS**

##### **Common initiators**

pesticides (particularly organophosphates and carbamates), solvents, carpets and glue, mercury amalgam, formaldehyde

##### **Common triggers**

air fresheners, alcohol, car exhaust, cleaners/detergents, cosmetics, foods, nail varnish, newly painted rooms, newspapers/printed material, perfumes, solvents, tobacco smoke.

##### **Multiple chemical sensitivity**

Brian Harris had been a photographer all his life until an accident at work exposed him to photographic chemicals. He was diagnosed with multiple chemical sensitivity, and is so sensitive to several chemicals that he can no longer work as a photographer, or enjoy an evening at the pub, and doubts that he will ever work again.

In 1997, after a five year legal battle supported by his union MSF, Brian won a £32,000 out-of-court settlement from Siemens. £28,000 was clawed back by the DSS, and Brian is still fighting for his retirement pension. Like Tony Bradshaw, Brian worked for a large employer that he expected would safeguard his health. He also blames the law for failing to protect him.

Brian, 57, worked for Siemens Plessey at Cowes on the Isle of Wight from 1982 to 1992. Originally employed as a photographer, he also had to develop and print the photographs as the department was so small. "Although I didn't go there to do processing, we all mucked in," Brian says.

Over 1,000 people worked on the Cowes site, but according to Brian, health and safety was not high on the company's agenda. Even getting them to hold a fire drill was a battle. He says, "Health and safety was an inconvenience to them. Their attitude was, 'Why spend money on health and safety when, if you forget it, it doesn't cost you anything?'"

When Brian arrived at Siemens, the photographic unit was housed in what looked like an old cow shed. "It was a joke on site," Brian says. "You couldn't print if it was windy because the walls used to vibrate and shake the enlarger." And the converted building they moved into in 1991 was not much better. Brian remembers, "The studio was far too small, and ventilation was the last consideration. It was cleaner, but that was all."

Brian traces his chemical sensitivity to the early autumn of 1991, when an old Kryonite colour processor was converted to run at a higher temperature, using 'rapid access' chemicals. Despite the change, no new COSHH assessment was done. One evening soon after the conversion Brian went home and remembers that his eyes felt sore, which he mentioned to his boss the following day.

Two days later the Water Board warned Siemens that supply to the site would be cut off for part of the day. Although the Kryonite processor needed circulating water, Brian was told to keep it running to finish an urgent job.

As Brian explains, "The day of the accident they cut the water supply off. I could smell the fumes, they were stinging my eyes, but of course you don't know that it's going to do you any damage. I told the boss

three times that something was wrong, but he told me they had to have the film that night. The process ran at a much higher temperature – I think that was half the problem – plus there was no water in this machine the day of the accident, so the chemicals were not being washed off. They were going through a heated chamber to dry the film, that was giving off fumes into the working area. There were two of us in there and both of us were affected. At home that night I was violently sick, and when I came in the next morning the fumes were still there. It looked like someone had been smoking in the room. Within 20 minutes John (Brian's colleague) passed out." That weekend Brian was no better. "I was vomiting, and had pains in my knuckles, arms and spine. I hurt all over. I thought I had 'flu," he says.

Brian returned to work the following week, and worked in the department until February 1992. He still suffered from skin and eye irritation, vomiting and joint pains, but as well as suffering symptoms at work, chemicals outside work were also beginning to trouble him. In August 1992, Brian retired and has found it very difficult to get work since then. He says, "I don't think any employer will ever look at me. If I could get a job at my age, which is not going to be easy, it only takes someone walk in wearing scent and I become ill again." Brian now spends much of his time outside, where he feels better, flying model aeroplanes. "I have come to terms with it," he says. "I used to enjoy going to pubs and restaurants, but all the pleasure has gone out of it now ...I fly my gliders, and stay out in the fresh air. I'm lucky I live here. If I lived in town, I don't know what I'd do." But what Brian has not come to terms with is that the law failed to protect his health, and that Siemens were not prosecuted or fined.

"To me, COSHH is a useless law. It's an absolute waste of time – a management tool used against employees – it has no effect on the shop floor. This could have been prevented if the COSHH Regs meant anything. If COSHH had teeth, it would have meant that someone would have been responsible for checking the equipment, the chemicals and the ventilation, and that if there was a problem someone had the authority to say 'stop' ...I can't ever put into words what they did to me," he says.

**Researching MCS** In their book on multiple chemical sensitivity (MCS), Drs Nicholas Ashford and Claudia Miller say, "In recent years, we have

observed a tendency to name MCS-like conditions after the suspected initiating event, for example, darkroom disease and Gulf War syndrome... This may cloak a larger view that there is an underlying, unifying mechanism, for example, that some people lose tolerance following certain chemical exposures, and that thereafter their symptoms are triggered (and their illness is perpetuated) by common, low-level exposures."

Exposures that appear to initiate MCS are most often pesticides (especially organophosphates) and solvents. However, once the illness has a foothold, triggers are often substances like perfumes, tobacco smoke or cleaning agents. Because of this, patients often mistake triggers for the initiator.

They cite recent US research, involving random telephone surveys, which found that around 5% of people reported symptoms of MCS. In other surveys, 15–34% said they were unusually sensitive to certain chemicals. Although there are now many theories about the mechanisms involved in MCS, much more research is needed. According to Ashford and Miller: "Funding agencies will need to make a much greater financial commitment if progress is to be made... [By] not understanding the causes of chemical sensitivity, we take an immense gamble – but knowledge will not come cheaply. Understanding chemical sensitivity is pivotal to establishing sound environmental policy. If there is a subset of the population that is (or can become) especially sensitive to low-level chemical exposures, a strategy for protecting them must be found" (N. Ashford and C. Miller, *Chemical exposures – low levels and high stakes*, 2nd edition, Van Nostrand Reinhold, 1998).

## FIRE, EXPLOSION AND RADIATION

Many chemicals used at work are flammable or explosive, either on their own or when mixed together. Dust explosions can also occur if enough dust of any solid material in the air is ignited by a flame or spark. Risks of fire and explosion need to be controlled by storing and handling chemicals correctly.

Certain chemicals emit ionising radiation, a specific type of radiation in the electromagnetic spectrum (other types include radiowaves and visible light). Some kinds of ionising radiation penetrate body tissues. High doses of radiation, as occurred after the dropping of atomic bombs on Hiroshima and Nagasaki, and in Chernobyl after the nuclear reactor accident, are lethal. At low doses, ionising radiation causes DNA damage and so can lead to cancer. Workers at risk of exposure to ionising radiation include those in hospitals

and laboratories. The Ionising Radiation Regulations 1985 require that exposures are kept "as low as is reasonably practicable". Exposure above specified single and annual doses must be reported to the HSE. The regulations also specify that certain areas be designated as "controlled areas" or "supervised areas" according to likely radiation exposure. Employers must also appoint qualified radiation protection advisers in workplaces with "controlled areas" or where doses above a certain level occur. New regulations to implement two Euratom directives will come into force during 2000. A European directive on physical agents, which would have covered non-ionising radiation, appears unlikely to see the light of day.

## TOXICITY TESTING

Understanding how chemicals are tested for toxicity is very important for trade union safety reps and members as users. The results of these tests often appear in safety data sheets, they are used to decide how chemicals are used, controlled, labelled, and, most importantly, in setting occupational exposure limits. Newly introduced chemicals are now required to have a certain set of toxicity data, but these do not exist for many chemicals already in use before legislation was introduced. It is important to remember that absence of evidence of risk is not the same thing as evidence of absence of risk.

In 1992, the United Nations Conference on Environment and Development called on member countries and the Organisation for Economic Co-operation and Development to complete toxicity testing for 2,550 industrial chemicals produced in high volumes (at least 1,000 tonnes per year in any member country). In 1998 the OECD announced it had completed 109 tests.

How much (or how little) is known about the toxicity of even the most widely used chemicals sparked a major debate in the US press during 1997, between the Environmental Defense Fund (EDF) and the Chemical Manufacturers' Association (CMA). The EDF said that toxicity data was inadequate for 71% of the 3,000 chemicals made and used in the USA in the highest amounts. The CMA disagreed, saying the figure was only 53%, but only because they included industrial data that had not been made publicly available. The US Environmental Protection Agency said, "There is a problem with public availability of basic screening information on chemicals."

To try and speed up this voluntary approach to testing, the EDF mounted a 'naming and shaming' campaign. They asked the top 100 chemical companies if they would find and disclose basic toxicity data on the high-

volume chemicals they produced by January 2000. The names of those which would not commit themselves were then listed in US newspaper advertisements (*Chemical and Engineering News*, 8 September 1997, pp. 27–29).

According to UK academic Professor Andrew Watterson of the Centre for Occupational and Environmental Health, “The demands of carrying out complete health assessments on the tens of thousands of chemicals, metals and other substances used in the world today are beyond the resources and abilities of the global scientific community.” Instead, he argues for a precautionary approach such as toxics use reduction (A. Watterson, *Toxics use reduction: a case study in managing risk in workplace and wider environments with reference to MDF*, De Montfort University, 1998).

## Testing for the effects of acute exposure

Toxicity studies can be divided into laboratory studies using live animals (*in vivo* studies) or groups of cells (*in vitro* studies), and studies of human populations (epidemiological studies). Animal studies are used to test chemicals for their acute and chronic toxicity by various routes of exposure. The standard way of measuring a chemical’s acute toxicity is to feed it at a range of single doses to groups of laboratory animals, such as rats. The dose that kills 50% of the group, the LD<sub>50</sub> (lethal dose-50), is then recorded as well as the effects noticed in the animals. One use of LD<sub>50</sub> values is in deciding how to label chemicals under the Chemicals (Hazard Information and Packaging for Supply) (CHIP) Regulations.

**Table 5: Examples of toxicity measures**

### LD<sub>50</sub> Categories

category	LD <sub>50</sub> oral rat mg/kg
very toxic	less than 25
toxic	from 25 to 200
harmful	from 200 to 2000

### Acute toxicity of methyl ethyl ketone (MEK)

LD <sub>50</sub> oral rat	2,740 mg/kg
LD <sub>50</sub> dermal (skin) rabbit	13 g/kg
LC <sub>50</sub> (2 hour) inhalation mouse	40 g/m <sup>3</sup>

LD<sub>LO</sub> intraperitoneal (abdomenal)

guinea pig

2000 mg/kg

*The dictionary of substances and their effects* volume 1, The Royal Society of Chemistry, 1992

Table 5 lists various measures of the acute toxicity of MEK, and illustrates some of the differences that are used in these tests. Table 5 lists four routes of exposure, oral, skin, inhalation and intraperitoneal injection, and four of the most commonly used laboratory species. Inhalation toxicity is described as a lethal concentration-50 (LC<sub>50</sub>) rather than LD<sub>50</sub>, and concentrations are expressed as milligrams or grams of substance per m<sup>3</sup> of air, or in parts per million (ppm). The LC<sub>50</sub> is only meaningful if the duration of exposure is known. The other doses are expressed as milligrams (mg) or grams (g) of substance per kilogram (kg) of body weight.

A chemical's irritancy is tested by applying it to the eyes and skin of animals. One such test is known as the Draize test, which involves applying chemicals to rabbits' skin and eyes, rabbits being chosen because of their large and exposed eyeballs. The Draize test has frequently been criticised by animal rights campaigners, particularly when used to assess the irritancy of cosmetic products.

## Testing for the effects of chronic exposure

The effects of chronic exposure are also tested in animals. In these tests, the animals are fed, inhale, or have the chemical painted on their skins throughout their lives. The type and amount of disease they develop are then compared with the effects in a control group. The controls should be the same as the exposed group in every respect except the chemical exposure. They should, for example, be the same strain of the same species, and be fed the same diet. The differences in rates of various diseases are then tested by various statistical means to see if they are significant. Having an adequate control group is just one element of good experimental design, as is the number of animals used. If a study is badly designed, its results will not be reliable.

For example, when testing carcinogens on animals the US National Cancer Institute says that the chemical should be tested at two doses in both sexes of two species of rodent, and each group should contain at least 50 animals. One dose is often the highest dose that will not kill, or acutely poison, the animal. Although this means that positive results will not be missed just

because a high enough dose was not used, it means that predicting the effects of very low levels of the chemical is difficult. Trying to extrapolate (predict) what will happen at low doses, or what will happen in humans, are two of the major problems of animal testing.

## Dose-response

When the results of these tests are plotted on a graph, with dose along the bottom (horizontal axis) and response up the side (vertical axis), a dose-response curve is obtained. (It is still called a curve even if it is a straight line!) For example, the dose could be milligrams of chemical per kilogram of body weight per day (mg/kg/day) and the response could be the percentage of animals that got a certain type of cancer, or suffered a certain degree of liver damage.

The question of whether there is a threshold dose, below which there is no toxic effect (no observed effect level, or NOEL) is controversial, especially for carcinogens. Because many carcinogens act by damaging DNA, and once this damage has been done it is permanent and by definition results in an increased risk of cancer, many argue that there is no such thing as a safe dose of these carcinogens. Also, because cancer is such a serious disease, and so many gaps exist in our knowledge of how carcinogens act, it makes sense to take a precautionary approach. In the Carcinogens Approved Code of Practice the HSE says, "The risk of cancer from exposure to a substance cannot in most cases be presumed to be zero except by eliminating exposure." NOELs are also used in setting occupational exposure limits.

"We assume that every molecule of benzene to which an individual is exposed has some finite risk, albeit small, of producing a mutation that may result in acute myelogenous leukaemia" (B. Goldstein and H. Kipen in Levy and Wegman).

## How useful are animal studies? Attitudes of the public and toxicologists

Some researchers in Canada and the USA have done interesting work comparing the attitudes of toxicologists and the public towards chemical risks. The public is more likely than toxicologists to think chemicals pose greater risks, and also finds it difficult to understand the concept of dose-response relationships. The public is much more likely than toxicologists to think the results of animal carcinogenicity studies can be applied to humans.

The study also found much disagreement between toxicologists about how to interpret various results. No wonder the public is confused, when the US study says, "Among the most important findings in this study was... the high percentage of toxicologists who doubted the validity of the animal and bacterial studies that form the backbone of their science." Fewer toxicologists in industry than in university or government jobs agreed that animal carcinogens could reasonably be expected to cause cancer in humans [P. Slovic et al., *Intuitive toxicology II. Expert and lay judgements of chemical risks in Canada*, *Risk Analysis*, 1995, **15**(6), 661–675; N. Kraus et al., *Intuitive toxicology: expert and lay judgements of chemical risks in Canada*, *Risk Analysis*, 1992, **12**(2), 215–232].

"Good toxicology recognises its limits, its gaps in knowledge and the debates about the validity of its understanding of the mechanisms of toxicity in the context of moving towards practical public health precautionary policies on toxics use in our workplaces," (A. Watterson.)

## Testing for carcinogens

As well as long-term animal tests, a range of other tests are used to predict whether a chemical is likely to cause cancer. These are done with cell cultures, for example using mouse lymphoma cells, and micro-organisms such as the bacteria *Salmonella* (the Ames test) and *Escherichia coli*, and are known as *in vitro* (literally, in glass) tests. They are quicker, cheaper, and more ethically acceptable than animal tests. They test a chemical's ability to damage genetic material (genotoxicity), although as mentioned before, most but not all genotoxins cause cancer, and (more importantly) not all carcinogens act by damaging genes. These would not, therefore, be detected if only *in vitro* tests were used. While animal and *in vitro* testing might provide regulators with a lot of data, because the mechanisms leading from exposure to effect are often unknown, there is still much educated guesswork involved in risk assessment.

Some human testing of chemicals does occur, e.g. by Zeneca in the UK.

### Genetic toxicology tests

#### Tests for gene mutations in bacteria

*Salmonella*

*Escherichia coli*

**Tests for gene and chromosome mutations in mammal cells**

Chinese hamster ovary (CHO) cell assay

Chinese hamster lung fibroblast assay

L5178Y/tk<sup>+/+</sup> mouse lymphoma cell assay

**Tests for chromosome mutations**

chromosome aberration in CHO cells *in vitro*

chromosome aberration in human lymphocytes *in vitro*

micronucleus test in erythrocytes from mouse bone marrow *in vivo*

dominant lethal test in rodents

**Tests to measure repair of DNA damage**

sister chromatid exchange *in vitro* or *in vivo*

unscheduled DNA synthesis *in vitro*

“Most animal tests and epidemiology studies are pretty much limited to high-dose-high-risk situations,” J. V. Rodricks. “Even our best scientific methods still depend heavily on extrapolations and judgements in order to infer human health risks from animal data,” A. Watterson. “Workers are often the ‘canaries in the coal mine’ who first demonstrate that a chemical is carcinogenic,” H. Frumkin.

## Epidemiology

The other way of studying the toxic effects of chemicals is to look at patterns of disease in human populations, such as groups of exposed workers. These are obviously more relevant, because they involve humans rather than animals, but can be difficult to interpret. They can also only be done after human exposure has occurred. But they do allow populations to be followed who have been exposed to chemicals cleared by toxicologists. The main types of epidemiological study are case-control studies and cohort studies.

Case-control studies compare a group of people with a specific disease with another (control) group who do not have the disease but are the same in other respects, like sex, age and social class. Information is then collected on both groups' occupational exposures. Because neither their doctors nor employers are likely to have adequate records of which chemicals workers

have been exposed to, and in what quantities, epidemiologists often rely on people's memories. The results are expressed as an odds-ratio (OR). If the OR is significantly greater than 1.0, there could be a link between the exposure and the disease.

Cohort studies look at a group known to be exposed to a particular chemical, and compare their death rate or diseases with a similar, unexposed, group. The results are expressed as Relative Risk (RR). An RR greater than 1.0 suggests a link between the exposure and the disease(s). If a control group cannot be found, comparisons are made between the exposed group and the general population, and expressed as a standardised mortality ratio (SMR).

Epidemiologists weigh the evidence by looking at results from as many studies as possible, as well as the size of the OR, RR, the existence of a dose-response relationship, and biological plausibility (is there a believable basis for the exposure leading to the disease?). A scientific consensus may then be reached, as happens with the IARC cancer evaluations.

#### **Weighing the evidence: the Gardner hypothesis**

Epidemiology need not yield clear answers. For example, epidemiological evidence for a link between men's exposure to ionising radiation at work and the risk of their children developing cancer has been argued about for years. In 1990, Professor Martin Gardner published the results of a case-control study of families around the Sellafield nuclear plant. He said the higher rate of leukaemia and non-Hodgkin's lymphoma in the children of radiation workers was due to their fathers' occupational exposure to radiation. The so-called "Gardner hypothesis" has been debated ever since, most recently in a report from the National Radiological Protection Board, who said that the increased incidence of childhood leukaemia and non-Hodgkin's lymphoma was not due to their father's work, because there was no dose-response relationship. In other words, the NRPB said that the fathers' exposure did not cause the children's disease because there was not more disease in the children of men with greatest exposure to radiation (A. Draper et al., *Cancer in the offspring of radiation workers – a record linkage study*, NRPB, 1997, ISBN 0 8595 1412 9).

### **Healthy worker effect**

The results of epidemiological studies obviously depend on the comparisons made between the cases and control groups used. If the groups are not well

matched, the results will not be meaningful. For this reason cases and control groups may be matched for age, sex and race, as well as lifestyle factors like smoking and alcohol consumption. Occupational groups very often have lower total mortality than the general population as the latter includes people unable to work due to illness or disability. In other words, any group of workers is likely to be more healthy than the population as a whole, a phenomenon known as the "healthy worker effect" (*Encyclopedia of occupational health and safety*, ILO, 1998).

## Other factors

Different people can respond very differently to the same dose of a chemical, and this variation is due to many factors. Age, sex, and genetics all influence how susceptible people are to chemicals. People can also be more at risk from toxic chemicals if taking certain drugs, if they have certain diseases, and if they are exposed to mixtures of chemicals.

The very young and the old are usually more susceptible to toxic chemicals than the rest of the population. In the young, this is because they can absorb relatively large doses of chemicals, the systems that detoxify chemicals have not yet matured, and parts of their body, such as their brains, are more easily damaged. Older people are more susceptible because they may have larger body stores of certain chemicals, and more of them have diseases which could put them at greater risk from toxic chemicals.

In addition to reproductive and developmental factors, men and women may differ in their response to chemicals in other ways. As women in general have lower body weight than men, they will be more strongly affected by the same dose of chemical. Different genetic make-up and different proportions of body fat may also have an influence. For example, as women have a higher proportion of body fat than men, they are more prone than men to retain organochlorine pesticides such as DDT once ingested. There are reports that women are more susceptible to skin diseases induced by chemicals and to the effects of indoor air pollution including multiple chemical sensitivity. The possibility of differential responses should be taken into account when performing risk assessments (*Encyclopedia of occupational health and safety*, ILO, 1998).

## Workers' epidemiology

Just because a scientific consensus does not exist, or research has not been done, does not mean that workers and safety reps should not act. Increasing

numbers of workers are doing their own research, usually helped by their trade unions. This is sometimes called workers' epidemiology, lay epidemiology or participatory research. It might involve gathering and analysing information by questionnaire, or pinpointing health problems by body mapping. Getting useful information from a questionnaire depends on asking the right questions, and the best way of doing this is by developing the questionnaire within the group of workers concerned. There are, however, several standard questionnaires available to survey particular workplace health problems, which could be used as the basis of such a questionnaire. The GPMU, for example, is currently involved in piloting a questionnaire to measure the rate of occupational skin disease among printers in the Nottingham area. But gathering data is only the first step, the information will need to be analysed (cheap computer packages are available to do this) and acted upon!

"One of best sources of information on occupational hazards is one of the most frequently overlooked – exposed workers" (H. Frumkin in Levy and Wegman).

## Body mapping

Another method of spotting new or underestimated health problems at work is body mapping (see figure 2), which can also be organised by safety reps. The process involves getting a group of workers together who do the same job. Then, using two large maps or outlines of the body (one for the front and one for the back), workers mark (with coloured stickers or pens) areas of the body affected by their work. As they do so, they should give the group a brief explanation of what they have marked, and why, and these comments can be written around the edge of the map. *Hazards* magazine

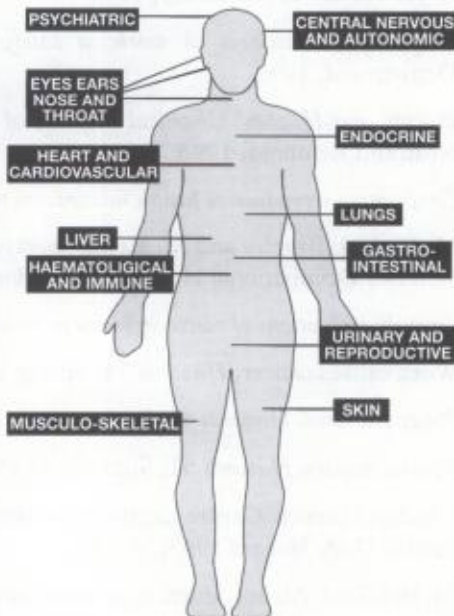


Figure 2: Possible sites of chemical poisoning  
PEGS

produces packs of body maps and has published information on body mapping and workers' epidemiology (Body of evidence, *Hazards*, Jan/Mar 1998, 61, pp.10–11; *Workers' Health International Newsletter*, Winter 1994/1995, pp. 10–11).

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## 3

## THE LEGAL FRAMEWORK

Chemicals at work are subject to a large and rapidly changing body of regulations. These do offer a measure of protection to workers and the public and there is every reason for safety representatives to be adequately informed about their scope. But this should also involve an appreciation of their limitations and the realisation that they do not provide sufficient protection on their own, not least because of the way in which they enforced.

### CONTROL OF SUBSTANCES HAZARDOUS TO HEALTH (COSHH) REGULATIONS

The Control of Substances Hazardous to Health Regulations, known as COSHH, are the most important piece of UK legislation on chemical hazards at work. COSHH applies in Great Britain and an equivalent law applies in Northern Ireland. COSHH was enacted in 1988, and began to come into force in October 1989. The Regulations were amended in 1994 and again in 1999. The main impact of the 1999 amendment was to prohibit the supply of eight chlorinated solvents in certain applications, such as degreasing. The new set of COSHH Regulations, rather than another amendment to the existing law, came into force in March 1999.

#### Changes under COSHH 1999

COSHH 1999 imposes exactly the same duties on employers as COSHH 1994, except:

- ▲ new or revised Maximum Exposure Limits will be published in EH64 approved, after consultation, by the Health and Safety Commission rather than the Secretary of State
- ▲ schedule 8 (the list of substances and processes defined as carcinogenic) will be revised
- ▲ the definition of a substantial concentration of dust, and the required frequency for monitoring hazardous substances will be transferred from the Code of Practice

- ▲ UK armed forces will have right of appeal against a medical decision to suspend from work.

COSHH applies to virtually all UK workplaces, including offshore oil and gas installations, but not crews on board sea-going ships. By 'substances hazardous to health' COSHH means biological organisms and dusts, as well as chemical substances or mixtures of substances. It includes substances *used* at work, like solvents, as well as those *generated* by work, like fume from solder flux. COSHH does not cover lead or asbestos, which have separate sets of regulations, or substances which are hazardous *only* because they are radioactive, asphyxiants, at high pressure, at extreme temperatures, or have explosive or flammable properties. The main legal duties of employers under COSHH are contained in Regulations 6–12 which cover risk assessment, prevention or control of exposure, use and maintenance of controls, monitoring exposure, health surveillance, and provision of information and training.

## Regulation 6: Assessment of health risks

The Approved Code of Practice (Acop) says, "An employer shall not carry on any work which is liable to expose any employees to any substance hazardous to health unless he has made a suitable and sufficient assessment of the risks created by that work to the health of those employees and of the steps that need to be taken to meet the requirements of these Regulations.

The assessment... shall be reviewed regularly and forthwith if (a) there is reason to suspect that the assessment is no longer valid or (b) there has been a significant change in the work to which the assessment relates, and, where as a result of the review, changes in the assessment are required, those changes shall be made."

### Organophosphate sheep dips

Robert Shepherd was poisoned by organophosphate (OP) pesticides. His health was damaged not by accident, but through regular exposure to sheep dip at work. Now aged 62, Robert became so ill he had to take ill-health retirement in 1991. With the help of his trade union, UNISON, in 1998 he won an out-of-court settlement of £80,000.

Robert Shepherd had worked as a farm manager for Lancashire County Council at the agricultural college since 1975. One of his jobs was to dip the college's flock of sheep. He first became ill in 1979 and by 1991 his

symptoms, tiredness, irritability and loss of concentration, became so bad that he had to retire. It was only after he watched a TV programme on OP poisoning that Robert realised he had been poisoned by the sheep dip he used at work.

Unlike others involving farm workers, Robert's case was quite clearly due to sheep dip. He had only ever worked as a shepherd and had not used other chemicals. According to Dr Goran Jamal, a clinical neurophysiologist, "Mr Shepherd worked all his life as a shepherd, and handled nothing but these toxic chemicals. This pointed to organophosphates damaging his health. This case is building up a pattern of proof of such immense public health importance that the authorities should act on this evidence. There have been a string of cases which are beginning to put a very serious question mark over the alleged safety of these compounds."

In fact, questions have been asked about the health effects of OPs for almost a century. In 1900 nerve damage was reported in tuberculosis patients treated with OPs. Although the acute effects of OPs are widely accepted, some still doubt that these chemicals cause the kind of chronic damage that Robert suffered.

Robert says the college did not give him advice or protective equipment when he started work. Instead, he had to rely on manufacturers' labels, and says, "I don't feel they gave proper safety advice or warnings about what symptoms to look out for." According to pesticide expert Professor Andrew Watterson, "Any responsible employer, especially one involved in education on agriculture, which includes occupational health and safety, would have been familiar with good practice and the hazards of sheep dip... In 1978, the Agricultural Training Board produced a trainees' guide on sheep dipping which would have been distributed to all agricultural colleges. It specifically refers to the need to wear rubber gloves, waterproof bib, face shield and rubber boots when dealing with dips."

Bronwyn McKenna, head of the legal department at UNISON agrees. She says, "As an agricultural college, they should have had access to the most up-to-date information about the dangers of sheep dips, not only to warn their staff but to protect their students. This case underlines the fact that the Council should have carried out detailed risk assessments and taken measures to provide personal protective

clothing, as well as introducing an adequate system of monitoring the dipping process.”

But for Robert, the damage is done. “My job was my life, and suddenly it all came to an end. I would like to see the damn stuff taken off the market. I don’t want anyone else to suffer the way I have,” he says.

In a 1996 study of 23 Welsh sheep farmers and a dipping contractor, all of whom used OPs, none used adequate personal protective equipment, complaining that it was too hot and made handling sheep very difficult. Only one farmer had done a COSHH assessment [H. Rees, Exposure to sheep dip and the incidence of acute symptoms in a group of Welsh sheep farmers, *Occupational and Environmental Medicine*, 1996, 53(4), 258–263].

In 1996, a study of pesticide use by over 1,000 members of the European Federation of Agricultural Workers (EFA) found at least 20% thought they had been made ill by the pesticides they used, only 35% used personal protective equipment although it was available to 77% of workers, and the symptoms most commonly reported were headaches, skin irritation, stomach pains, vomiting, eye irritation and diarrhoea (*Pesticides News*, June 1997, 36, p. 7).

As part of the COSHH assessment, an employer must look at the types of substances workers are exposed to, what effects these could have, and estimate the current levels of exposure. They then need to consider whether exposure can be prevented, or if not, how it can be controlled.

Whoever does the assessment must be competent to do so (Regulation 12). The HSE says, “Except in very simple cases, whoever carries out the assessment will need to have access to and understand the requirements of the COSHH Regulations and appropriate Approved Codes of Practice, have the ability and authority to get all the necessary information, and the knowledge and skill to make correct decisions about the risks and the precautions needed. **Remember that you and your employees have the most knowledge of what really happens in your workplace.**”

Safety reps have legal rights to be consulted on COSHH assessments, and should remember that safety data sheets are just one source of information on a chemical’s hazards. A collection of manufacturers’ or suppliers’ data sheets alone is not a COSHH assessment!

## **Regulation 7: Prevention or control of exposure**

The Acop says, “Every employer shall ensure that the exposure of his employees to substances hazardous to health is either prevented or, where this is not reasonably practicable, adequately controlled.”

COSHH introduced what is known as a ‘hierarchy of controls’ to protect workers from exposure to hazardous substances. This means that an employer, where it is ‘reasonably practicable’, should change the process, so the substance is no longer used or produced, replace a hazardous substance with something safer, or enclose the process. If exposure cannot be prevented, employers must control exposure by using engineering controls, like local exhaust ventilation or, as a last resort, personal protective equipment.

Special provisions apply to carcinogens. If exposure cannot be prevented by using an alternative process or substance then the process should be totally enclosed if reasonably practicable. COSHH lists seven controls which *must* be used for carcinogens, including limiting the quantities used, and keeping the number of exposed workers to a minimum.

## **Regulation 8: Use of control measures**

Every employer who provides any control measure should ensure that it is fully and properly used.

## **Regulation 9: Maintenance, examination and test of control measures**

The Acop says, “Every employer who provides any control measure to meet the requirement of Regulation 7 shall ensure that it is maintained in an efficient state, in efficient working order and in good repair and, in the case of personal protective equipment, in a clean condition ... Every employer shall keep a suitable record of the examinations and tests carried out ... and of any repairs carried out as a result ... and that record or a suitable summary thereof shall be kept for at least five years from the date on which it was made.”

## **Regulation 10: Monitoring exposure**

The Acop says, “In any case in which (a) it is requisite for ensuring the maintenance of adequate control of the exposure of employees to substances hazardous to health or (b) it is otherwise requisite for protecting the health

of employees, the employer shall ensure that the exposure of employees to substances hazardous to health is monitored in accordance with a suitable procedure." Records must be kept for 40 years in the case of personal exposures of identifiable employees, and at least five years in other cases. Monitoring should be at least once a year (except for vinyl chloride monomer, where monitoring must be continuous, and in chromium plating where monitoring must be every 14 days).

## **Regulation 11: Health surveillance**

The Acop says, "Where it is appropriate for the protection of the health of his employees who are, or are liable to be, exposed to a substance hazardous to health, the employer shall ensure that such employees are under suitable health surveillance."

Surveillance is required for workers exposed to vinyl chloride monomer, nitro or amino derivatives of phenol or benzene, potassium or sodium chromate or dichromate, *o*-toluidine, dianisidine and dichlorobenzidine and their salts, auramine, magenta, carbon disulphide, disulphur dichloride, benzene (including benzol), carbon tetrachloride, trichloroethylene, and pitch.

Health surveillance is also required where "an identifiable disease or adverse health effect may be related to the exposure." This would apply, for instance, to workers like Violette Hutchins who are exposed to fume from colophony-based solder flux.

Surveillance can include clinical examinations, or testing body fluids or exhaled air. Employers must allow employees access to their health records.

EH40 contains a handful of biological monitoring guidance values (BMGV), including BMGVs for lindane and MbOCA. These are not statutory, and are published for guidance only. Even if they are being met, this does not mean an employer need do nothing more to reduce exposure, but if they are exceeded it does mean employers should investigate the controls they are using. Just because a substance does not have a BMGV in EH40, does not mean an employer need not do any biological monitoring. The BMGVs are not an alternative to, or replacement for, occupational exposure limits.

## **Regulation 12: Information, instruction and training**

The Acop says, "An employer who undertakes work which may expose any of his employees to substances hazardous to health shall provide that

employee with such information, instruction and training as is suitable and sufficient for him to know (a) the risks to health created by such exposure and (b) the precautions which should be taken.

This includes the results of any monitoring and the Regulation requires workers and safety reps to be informed if Maximum Exposure Limits have been exceeded.

## **Carcinogens**

The Carcinogens Acop is intended to be used alongside the General COSHH Acop, not as a replacement for it. The Carcinogens Acop stresses that “prevention of exposure to carcinogenic substances must be the first objective ... Carcinogenic substances or processes should not be used or carried on where there is an equivalent but less or non-hazardous substitute. However, carcinogenic, toxic and other properties of possible chemical substitutes should be established and taken into account when considering changes.”

The Acop also says that exposure monitoring should be the norm, and that health surveillance is appropriate “in the case of all carcinogenic substances, unless exposure is not significant.” Regulation 11 also says, “In view of the usual latent period between exposure to a carcinogenic substance and any health effect, employees who have been exposed to carcinogenic substances should be provided with information about any need for continuing health surveillance after exposure has ceased.”

Regulation 4 of COSHH prohibits use of a handful of carcinogens which are listed in Schedule 2 of the Regulations. These include 2-naphthylamine, benzidine, 4-aminodiphenyl, 4-nitrodiphenyl (or substances containing them or their salts), and benzene. Under COSHH, a carcinogen is defined as any substance in the category of “danger, carcinogenic” (category 1) or “carcinogenic” (category 2) in the CHIP Regulations, or listed in schedule 8 of COSHH.

**Other substances and processes to which the definition of “carcinogen” relates (COSHH, Schedule 8):** aflatoxins, arsenic, electrolytic chromium processes, excluding passivation, involving hexavalent chromium compounds, mustard gas, calcining, sintering or smelting nickel copper matte or acid leaching or electrorefining of roasted matte, coal soots, coal tar, pitch and coal tar fumes, some mineral oils, auramine manufacture, leather dust in boot and shoe manufacture, hard wood dusts, isopropyl alcohol manufacture (strong acid process), rubber manufacturing and

processes giving rise to rubber process dust and rubber fume, and magenta manufacture.

Information on carcinogens is also found in safety data sheets and on labels, including the risk phrases "R45 (may cause cancer)" and "R49 (may cause cancer by inhalation)" required by the CHIP Regulations. CHIP lists over 100 chemicals with these particular risk phrases. Another source of information on carcinogens is the International Agency for Research on Cancer. The Carcinogens Acop points out how important it is for workers and safety reps to have information over and above that required by the General Acop. Regulation 12 says, "Persons exposed, or liable to be exposed, to carcinogenic substances, and their representatives at the workplace, should be made and kept aware of the nature of the risk, the special features of carcinogenic substances and the circumstances in which they may be exposed to carcinogenic substances, in addition to the information specified by the General Acop" (*General COSHH ACOP and Carcinogens ACOP and Biological Agents ACOP L5*, HSE, 1997, ISBN 0 7176 1308 9).

## Enforcing COSHH

Although COSHH has been in force for a decade, much criticism levelled against it in the early 1990s remains true. Unfortunately, however good a law is on paper, it only protects workers if implemented by employers and enforced by the authorities. The HSE did its own survey of how employers were getting to grips with COSHH in 1991/92, two years after the law came into force. They visited 536 employers and found 38% were complying with COSHH, 75% had done assessments, but only three-quarters of these complied with the law, 27% of COSHH assessments were "less than suitable and sufficient", 36% of premises where COSHH required health surveillance were not doing so, and about 80% gave workers information and training which was "satisfactory or with minor shortcomings". Commenting on the survey, the HSE said, "The most common fault has been for assessments to consist of little more than collections of data sheets, without the all-important evaluation of the risks arising from those hazards."

### Two more sewer deaths

In August 1996 three tonnes of the refrigerant Freon 11 (trichlorofluoromethane) leaked into the sewerage system between Swansea and Cardiff. The chemical was being transferred from an ICI tanker into drums by workers from Gower Chemicals. At the end of the

job, they reported that they had only filled 56 barrels, instead of the 66 they expected to be in the tanker. Their supervisor contacted ICI, but nothing else was done and the missing Freon, which had leaked from the tanker, remained in the drains.

Two months later, on 10 October 1996, workers from Neath and Port Talbot Council were sent out to clean a sewerage chamber near the Gower Chemical plant. When their vacuum equipment became blocked, 27-year old Ryan Preece climbed down into the chamber to see what had happened. He never found out.

Preece had disturbed the pool of Freon 11 and was overcome by a cloud of toxic gas which filled the chamber. His work mate, Robert Simpson, 33, followed him into the sewer to try and help. When a third colleague, who had gone to call for help, returned, both Robert and Ryan were dead, floating face down in the sewer.

In December 1997, the Council was prosecuted by the Health and Safety Executive and fined £150,000 plus £43,000 costs at Cardiff Crown Court. The Council had given neither Robert nor Ryan confined-spaces training, they had no gas monitors, breathing equipment, first aid back up, or means of escape from the sewer. The HSE's regional director, Terry Rose said, "These two tragic deaths could and should have been avoided. The risks from entry to confined spaces, particularly those associated with sewage, are well known. Any such chamber may contain toxic or explosive gases, or lack enough oxygen to breathe. No one should ever enter confined spaces unless it is absolutely unavoidable. When entry is necessary, it is essential that the appropriate precautions are taken. The risks must be carefully assessed and proper safe systems of work put in place. People carrying out this type of work must be fully trained, properly supervised, and provided with the right safety equipment."

"There is no excuse for employers not to ensure that suitable controls for confined space entry are put in place... Robert Simpson and Ryan Preece's deaths could have so easily been prevented if the right precautions had been taken. Hopefully all Local Authorities and the many other employers who undertake this type of work will check again that their employees are fully protected, and make sure that there are no further deaths."

At the inquest into the deaths in April 1998, verdicts of unlawful killing were returned, but the families and 34,000 people who signed a petition

want to see criminal proceedings brought by the Crown Prosecution Service (CPS). Ryan's sister Karen Stacey said, "I won't stop until I get justice in the criminal court."

While the CPS reconsidered prosecution, Gower Chemicals were taken to court by Welsh Water. They pleaded guilty to two technical charges of breaching their discharge licence, and were fined £100,000 plus £33,000 costs.

Early in 1999, the CPS finally announced that it was not going to prosecute (*The Western Mail*, 15 April 1998; *South Wales Evening Post*, 15 April 1998).

In April 1992 the HSE also telephoned 2,000 randomly selected employers with fewer than 50 employees. It found 62% had heard of COSHH, 65% had not started their assessments, and 42% admitted they had done nothing.

In 1997, the HSE published research which it had commissioned on employers' understanding of OELs and COSHH. Managers responsible for health and safety in 1,000 businesses, plus 150 union safety reps, were interviewed by telephone in mid-1996. 35% of managers admitted they had never heard of COSHH, or did not know what it was about. Although 45% of managers claimed they knew what an OEL was, when asked further questions to check their understanding, the research found that "there is a hard core of 15–20% who are largely ignorant."

Although not directly comparable, the results for the safety reps found that only 11% admitted they had never heard of COSHH, or did not know what it was about, and 69% of reps claimed they knew what an OEL was. According to the survey, "trade union reps aware of OELs demonstrated a better understanding of them than their counterparts in the user [manager] survey."

Commenting on the results, Murray Devine, Head of HSE's Chemicals Policy Division said, "OELs are a pillar of the COSHH regulations and... I am concerned that OELs are not better understood and used."

These surveys all suggest that there is a hard core of employers who are just not getting the message on chemicals, or if they are, they are ignoring it. All the evidence suggests that these are small and medium-sized enterprises (SMEs), precisely the businesses which employ most of the UK workforce, and where trade union membership is most patchy.

## New help for small firms

Partly because of the survey on OELs, the HSE decided on another attempt to get through to SMEs using chemicals. It launched a new approach to controlling chemicals in SMEs in 1999, described as a "scheme of generic risk assessment". Mike Topping of the HSE says, "Chemicals are still making people ill (yet) occupational ill-health is all potentially preventable. Some requirements of COSHH are beyond the expertise of small firms." This does not mean that small firms no longer have to comply with COSHH, but it gives them a simpler way of assessing chemical hazards, and much more practical guidance on controlling them.

Realising how difficult it is to get information to SMEs and their workers, the HSE scheme hinges on using suppliers to deliver chemical information. SMEs can use a step-by-step approach to risk assessment, beginning with the risk phrases given on chemical labels. After considering other information about the chemical, such as its dustiness or volatility, and the quantities used, employers can work out what controls are needed. Implementing the controls is explained in 60–100 'control guidance sheets' which employers can get from the supplier or the HSE.

Trade unions like the GPMU support the new scheme, and they and other unions are key routes through which to get information on controlling chemicals in small firms. Bud Hudspith, the GPMU's health and safety officer, thinks this move away from goal-setting to more specific, practical advice is a step in the right direction. "It is rare to find adequate COSHH assessments in printing. They are often just collections of safety data sheets," he says.

However, for the scheme to protect workers, the information on chemical labels will need to be improved. A 1997 survey by European Union health and safety enforcement agencies found 40% of chemicals wrongly classified and labelled. Safety data sheets were available for only 66% of the substances.

## OCCUPATIONAL EXPOSURE LIMITS

Occupational exposure limits (OELs) have legal status under COSHH, and they are listed in the Health and Safety Executive (HSE) publication EH40, which is updated annually. The 1999 list is called EH40/99. Employers must compare OELs in the list with exposure levels measured at work, to ensure that exposure is being controlled. However, just because a substance does not have an OEL does not mean that it is safe.

## MELs and OESs

There are two types of OEL, Occupational Exposure Standards (OESs) and Maximum Exposure Limits (MELs). Both refer to concentrations of a substance in air, averaged over 8 hours and/or 15 minutes, but there are very important differences between them. They are set in different ways, and employers have different legal duties with respect to them.

The HSE says, "An OES is set at a level that (based on current scientific knowledge) will not damage the health of workers exposed to it by inhalation day after day." In contrast, "MELs are set for substances which may cause the most serious health effects, such as cancer and occupational asthma, and for which 'safe' levels of exposure cannot be determined or for substances for which safe levels may exist but control to those levels is not reasonably practicable."

Where an OES applies, workers must not be exposed to levels above it, whereas an MEL requires employers not only to keep exposures below the MEL, but also to reduce exposure to a level **"as low as reasonably practicable"**. According to EH40, "In assessing reasonable practicability, the nature of the risk presented by the substance should be weighed against the cost and the effort involved in taking measures to reduce the risk."

## Setting limits

MELs and OESs are recommended by the HSC's Advisory Committee on Toxic Substances (ACTS), and its sub-committee, the Working Group on the Assessment of Toxic Chemicals (WATCH). Every year, ACTS and WATCH examine the scientific data on certain chemicals, and the chemicals on their agenda are published in EH40. The agendas and minutes of both committees' meetings are available on the Internet (<http://www.open.gov.uk/hse/hsehome.htm>). ACTS is a tripartite committee, including members from unions and employers. WATCH consists of technical experts nominated by employers, unions and independents. According to HSE staff, "The tripartite structure is considered important even at this technical level because, with incomplete information and various possible interpretations, a measure of judgement enters into interpretation of scientific data."

WATCH considers whether an OES can be set, and at what level. If WATCH considers an MEL is appropriate, it does not consider the value but refers it to ACTS. ACTS may or may not endorse the OES. If it agrees an MEL is appropriate, ACTS sets the level. Proposals and a summary of the review are published for public comment.

The HSE also uses its National Exposure Database (NEDB) in setting OELs. The NEDB is a database of over 500,000 measurements on 3,000 substances collected by the HSE. Much more data is held by employers and occupational hygienists, which could make the NEDB a much more useful tool, but employers are wary of passing it on to the HSE.

Because there is relatively little good data on the health effects of chemicals at work, members of WATCH also have to rely on educated guesswork. If information from animal studies is available which shows a no observed adverse effect level, WATCH uses this as the basis of the OES and adds an Uncertainty Factor. The size of the Uncertainty Factor depends on the amount of toxicological data, the number of species used in the studies, the routes of exposure studied, the reliability of the studies, the seriousness of the health effect, the slope of the dose-response curve, the workers' age, sex and health, and the cost of the controls.

HSE toxicologist Steven Fairhurst looked at 24 OESs set by WATCH between 1990 and 1993, and found Uncertainty Factors ranging from 1 to 40–60. The substance with the highest Uncertainty Factor was dimethylacetamide, which causes birth defects. Dr. Fairhurst says, "For many substances of relevance occupationally, the toxicological database is rather weak, in both quality and quantity. Critical assessment of each individual original data source has proved essential to ensure accurate portrayal of the study findings. It has also been necessary to exercise considerable predictive and judgemental skills in attempting to construct a coherent and substantial toxicological profile of a substance from the often rather patchy information available. The crucial question is whether or not the Uncertainty Factors applied are correct, such that the OES values confer the desired degree of health protection."

At the end of the deliberations, proposals for new or revised OESs or MELs are published in EH40. Now that COSHH 1999 has come into force, MELs are approved by the Health and Safety Commission and implemented by amending the COSHH Regulations.

"Not only one truth can be interpreted from several scientific data,"  
W. J. Hunter et al., *Occupational exposure limits for chemicals in the European Union, Occupational and Environmental Medicine* 1997, 54, 217–222.

Chemical Hazard Alert Notices (CHANs) have been introduced by the HSE for substances "where the current scientific information indicates that

it is not possible to identify with confidence a level of exposure which is judged to be both safe and realistically achievable.” While ACTS considers setting MELs for these substances, CHANs provide interim practical advice to safety reps and employers. A list of CHANs is on the HSE web site (<http://www.open.gov.uk/hse/hsehome.htm>) and in EH40. When a CHAN is issued, employers should obtain a up-to-date safety data sheet from the supplier or manufacturer. When WATCH and ACTS recommend a new or revised OEL, a summary of the scientific data they have examined is published by the HSE in an annually updated loose-leaf publication called *EH64 – Summary Criteria for Occupational Exposure Limits*. The are initially published in draft form to allow trade unions, employers and occupational health professionals to comment on them.

In 1997, the HSE launched a new series of ‘risk assessment documents’ called EH72. This series supersedes another called EH65. As well as a more detailed version of the WATCH assessment in EH64, EH72 documents also contain information on methods for measuring chemicals in workplace air and on biological monitoring.

## Exposure limits in Europe

In the European Union (EU), the Commission’s Directorate General V (DG V) is responsible for occupational exposure limits. A committee similar to WATCH, the Scientific Committee for Occupational Exposure Limits to Chemical Agents (SCOEL) gives advice on setting OELs, which then go to a series of committees and representatives of member states.

As in the UK, two kinds of OEL are set by DG V, Indicative Limit Values (ILVs) and Binding Limit Values. Except for limit values for asbestos, lead and vinyl chloride monomer, these EU limits are advisory only, not even minimum standards.

However, the EU has an indirect influence on UK limit values in two ways. For a substance classified by the EU as a probable or certain human carcinogen, exposure must be as low as technically feasible. This means the UK could not set an OEL for such a substance. And if an ILV is set by the EU which is different from the limit in EH40, or if there is no UK limit, the substance would be included in the WATCH programme.

## What’s wrong with limit values?

Threshold Limit Values (TLVs) have been published by the American Conference of Government Industrial Hygienists (ACGIH) since the 1940s, and have been very influential in much of Europe, Scandinavia, Japan and

in developing countries. According to HSE staff, "Britain has been producing its own exposure limits for about 11 years, and before that reprinted the ACGIH threshold limit value (TLV) list as guidance. (When COSHH came into force in 1989) many TLVs were adopted as OESs without further review ... Britain has set exposure limits following reviews of about 150 substances. Of the 150, about 100 have been given OESs and 50 have been given MELs. About 350 OESs remain which were simply taken from the TLV list."

In 1988 American occupational health experts exposed the influence of chemical companies over the ACGIH's TLV committee, and the secrecy that surrounds their work. A 1986 study, *Documentation of the Threshold Limit Values and Biological Exposure Indices* by Castleman and Ziem, found that for 104, or over one-sixth, of the under 600 substances listed, "important or total reliance was placed on unpublished corporate communications." ACGIH classified 11 substances as human carcinogens, and 40 as suspected human carcinogens. The equivalent German classification lists 17 human and 42 suspected human carcinogens.

The ACGIH is not part of the US government, but a voluntary organisation. In the mid-1980s, the annual budget of the TLV committee was just \$30,000, so it relied heavily on the voluntary work of its committee members. In return, Castleman and Ziem suggest, industry was rewarded with high TLVs which reduced the costs of regulation to the chemical industry. On the other hand, only occasional token efforts were made to get a trade union industrial hygienist onto the committee.

Castleman and Ziem were concerned that not only were chemical company representatives setting TLVs for substances that their own firms manufactured, but that the data they used to set limits was often supplied by the companies but never published. This means that independent scientists have no idea how good these studies were. They say, "The TLVs are assumed by many to be first world, 'first class' guidelines for worker protection. The consequences of such misplaced confidence in the TLVs are profound and global. The credibility of the ACGIH limits as scientifically, independently and verifiably determined persists as an obstacle to a better standard of worker protection ... It is time that we all openly acknowledge the political nature of decisions by unexposed scientists and regulators regarding maximum levels of chemicals to which other humans can knowingly be exposed. The decision process therefore must not only be freed from undue corporate influence; it must also include substantial participation by representatives of exposed persons."

## ASBESTOS REGULATIONS

Three pieces of legislation control work with asbestos in the UK. The Control of Asbestos at Work Regulations 1987 require employers to prevent the exposure of employees to asbestos. If this is not reasonably practicable the law says their exposure should be controlled to the lowest possible level. Before any work with asbestos is carried out, the Regulations require employers to make an assessment of the likely exposure of employees to asbestos dust.

The Asbestos (Licensing) Regulations 1983 require that a contractor doing more than two hours work with asbestos lagging or asbestos coating must be licensed. But in view of the high risk associated with these materials HSE recommends that you use a licensed contractor regardless of the length of time the job is likely to take.

The Asbestos (Prohibitions) Regulations 1992 prohibit the import and supply of amphiboles, and the use or supply of chrysotile asbestos. Asbestos spraying is also prohibited.

A consultation document published in 1998 proposes requiring a license for work with asbestos board, tightening exposure limits for chrysotile asbestos, requiring employers to provide refresher training, and tightening employers' duties on respiratory protective equipment. After much pressure from UK trade unions and hazards campaigners, and positive statements by Labour Ministers, a more or less total ban on chrysotile will be introduced in 1999.

## LEAD LAWS

New legislation governing exposure to lead at work came into force in April 1998. The Control of Lead at Work Regulations 1998 lowered the blood lead levels at which workers must be removed from work with lead. These suspension levels vary according to sex and age: for women of child-bearing age the blood-lead suspension level is 30 micrograms per decilitre of blood, for young people the level is 50 micrograms per decilitre, and for other workers, 60 micrograms per decilitre. If these blood-lead levels are exceeded, the employer must transfer the worker to other duties not involving exposure to lead, and if such work is not available the worker is entitled to up to six months pay under the Employment Rights Act 1996. The regulations also introduced new action levels below the suspension levels which, if exceeded, mean employees have a duty to investigate and remedy the cause. For women of child-bearing age the blood-lead action level is 25 micrograms per

decilitre of blood, for young people the level is 40 micrograms per decilitre, and for other workers, 50 micrograms per decilitre. The HSE estimates 15,500 UK workers are exposed to lead at levels requiring blood lead levels to be measured.

## LABELS AND SAFETY DATA SHEETS

Both labels and safety data sheets are important sources of information on chemical hazards, and they are governed by CHIP 99, the Chemicals (Hazard Information and Packing for Supply) Regulations 1999, and apply to companies which supply chemicals. CHIP 99 came into force in March 1999 and further amends the Chemicals Hazard Information and Packaging for Supply Regulations 1994 (CHIP 2). (The Regulations do not cover pesticides, medicines or cosmetics; these are covered by other legislation and have different rules for packaging and labelling.) Similar requirements apply to firms which transport chemicals by road or rail. These 'carriage requirements' are covered by the Carriage of Dangerous Goods by Road and Rail (Classification, Packaging and Labelling) Regulations 1994. These were once part of CHIP.

CHIP 99 requires suppliers of chemicals to identify the hazards (or dangers) of the chemicals they supply, provide information about the hazards of the chemical, via labels and in safety data sheets, and package chemicals safely.

Part of CHIP 99, the Approved Supply List, classifies over 2,500 substances according to their health and safety effects. These are listed on the label as pictograms, risk phrases (R-phrases) and safety phrases (S-phrases). If a chemical is not on the list, the supplier is expected to classify it using health and safety data. How to classify and label chemicals not on the Approved Supply List is described in the Approved Classification and Labelling Guide (ACLG).

Safety data sheets must be provided with all chemicals classified as dangerous, and although they can be sent separately from the chemical, they should not arrive after the product. CHIP 99 also specifies the type of information that safety data sheets have to contain. Safety data sheets must have 16 headings, including the chemical's hazards, how it should be handled, stored and disposed of, and what should be done in the case of an accident. The headings are 1, identification of the substance/preparation and company; 2, composition/information on ingredients; 3, hazards identification; 4, first aid measures; 5, fire fighting measures; 6, accidental release measures; 7, handling and storage; 8, exposure controls/personal

protection; 9, physical and chemical properties; 10, stability and reactivity; 11, toxicological data; 12, ecological data; 13, disposal; 14, transport information; 15, regulatory information; and 16, other information. Although these headings are obligatory, CHIP 99 does not specify exactly what information should be included under them. However, the HSE publishes an *Approved Code of Practice – Safety data sheets for substances and preparations dangerous or supply* which gives guidance on the sort of information that should be given under each heading.

## Why we can't trust safety data sheets

Manufacturers' and suppliers' safety data sheets vary enormously in quality, and while the best can be very important sources of information, the worst are neither accurate nor understandable. According to Bud Hudspith of the GPMU, "I am sorry to say that most suppliers' data sheets don't help much in doing COSHH assessments. We have a real problem in the supply chain. Information duties are often not met and are rarely enforced – it's a bit of a soft issue."

Because of this, and because of the large sums of money spent by UK chemical manufacturers on producing and distributing safety data sheets (some think at least £62 million) the HSE is planning to spend £2–3 million in 1999–2005 looking at getting chemical information to the right people in the right way. Although still at an early stage, the safety data sheet programme will look at current safety data sheet practices, and examine the best ways of communicating information on chemical hazards.

## PESTICIDES

As well as duties under COSHH, the use of pesticides is also covered by the Food and Environment Protection Act 1985 and the Control of Pesticides Regulations 1986.

### PEGS

Many of the other case studies in this book describe the effects of chronic exposure to chemicals at work. What happened to Cambridgeshire farmer, Enfys Chapman, resulted from a single massive exposure to organophosphate (OP) pesticides in July 1977. The events of that summer turned her life upside down.

One Thursday that July, Enfys was at home on the farm she and her husband owned near Cambridge. The Chapmans raised cattle, fodder

crops, and organic vegetables, and Enfys had built up a prize-winning Jersey herd from a single cow she bought from the University veterinary department.

"All of a sudden we heard a helicopter come past the house," she remembers. Realising that it was spraying her neighbours' fields, and that her cattle were outside, she went outside to see what was going on. "I hadn't realised they were spraying to such an extent until I ran out through the vegetable garden and was drenched with this stuff." The cows were also sprayed, and while her son moved them and hosed them down, Enfys set off over the fence to talk to the pilot. She was not reassured by what she learned about the chemicals he was using.

"He told me the spray was much safer than malathion, and that the cows could return to the field the next day. I am not a very believing person, and because he mentioned malathion, I knew it was an organophosphate, and that I couldn't put milk in the tank until I found out what the cattle had been exposed to."

Enfys and her sons began to feel ill very quickly. "We all began to feel a malaise and a headache, and the cows were behaving oddly," she says. "The cows all had blisters on their udders, and although I had made everybody shower and change their clothes we had blisters in our ears and in our eyes. We felt sick and had diarrhoea."

Enfys spent most of the afternoon trying to get help, but could get no reply from the Milk Marketing Board or the local HSE inspector. However, one local vet told her that if she put milk from the exposed cows into her bulk tank, she could kill half of Cambridge.

"The public health people very quickly put a stop on the milk and closed the farm shop," she says. The HSE told her not to dispose of the milk from exposed cattle down the drain, and also warned her sons to keep away from the cows, as the OPs could be a reproductive hazard. Finally, she was told to close the footpaths across her farm.

"It was pandemonium over the weekend. We had people wanting to buy food, we had milk we couldn't do anything with, and all of us that had been in contact with the stuff were feeling pretty ill; I worse than anybody," she remembers.

Five days later, Enfys suffered what she describes as a "massive spasm" and was rushed into Addenbrookes hospital by ambulance. She says, "I

was being thrown about so much [by the spasms] that they had to manacle me. The ambulance crew thought I had tried to commit suicide. They had a nightmare journey."

Enfys remained at Addenbrookes for a month. She had gone in a fit and active 48 year old, but says, "When I came out I probably looked like I was 78. I had lost my memory, I lost my sight, I couldn't use my hands, I couldn't walk properly, and I lost my hearing too. It was like fumbling in the dark. I had received five times the lethal dose for someone my weight, so I was very lucky," she says.

She also counts herself lucky because, as she puts it, "We were quite well connected in Cambridge – we had connections that a lot of other people would not." And it was those connections she used in 1988 when she and others set up PEGS, the Pesticide Exposure Group of Sufferers.

"We set out to collate as much information as we could on pesticide exposures and their adverse effects, so that if in due course the authorities became interested, we would have evidence to show what was happening. We have an enormous amount of information, and since 1990 the Government has been asking us for it, so we haven't really needed to go out campaigning. In fact, we couldn't campaign, we weren't fit enough, but we have managed to do quite a lot by providing information," she explains.

In the past 10 years PEGS has dealt with 11,000 enquiries, and held 22 meetings (or forums) throughout the UK. PEGS forums are held in areas with recent pesticide exposure problems, and have attracted up to 200 people. The forums are important for victims of pesticide exposure, Enfys says, because "it means they get to know people in their own neck of the woods. We have had three forums in Scotland, one in Ireland. Southern Ireland have formed their own group called PAIN, and we have helped set up groups in Sri Lanka, Morocco, Canada, and New Zealand."

She counts the forums as one of PEGS greatest successes. "The forums have been wonderful," she says. "I didn't think I could manage it, setting up meetings all over the place is a tremendous effort for someone who is not particularly well. But we have also seen people getting better, and I think we are going to get redress for people; not necessarily compensation for everything that has happened to them, but they are going to feel that they have got some redress for what they have suffered."

However, Enfys is acutely aware of those who have not recovered. In fact, they feel so bad as a direct or indirect result of pesticide exposure that many of PEGS' callers are suicidal. She says: "The worst thing is the suicides, the ones I haven't managed to stop. What a waste of life."

Although she thinks self-help groups like PEGS are important, she would like others to do more, and is disappointed that so many people are still being poisoned by pesticides. "I was surprised that in 10 years we had managed to do so much, but I was hoping that the problem would have eased off. It hasn't, and it's not getting any less. The reason so many people have problems is because they think that if a product is licensed then it is safe. If you are told it is safe, you do not query it. But nothing is safe, if it is meant to kill something, it is not going to be safe. It would be safer to do something else."

"I wish there was a readily accessible system for testing for pesticide exposure. You can get tested if you are lucky, but it is not readily accessible to everyone, and I hope centres will be set up to treat people who have suffered from chemical exposures, because it is not just pesticides, it is all kinds of chemicals."

HSE inspectors investigated 204 complaints about pesticide use between March 1996 and March 1997. Compared with the previous year, although the number of complaints rose by 21%, prosecutions were down 8% to 11, and enforcement notices down 35% to 185. The figures are for enforcement under the Food and Environment Protection Act 1985 or the Control of Pesticides Regulations 1986, not COSHH. They also exclude sheep-dip, which is classified as a veterinary medicine (*Pesticide incidents report 1996/97*, HSE 1997, INTS03 9/97 C2).

In June 1998, after a two year feasibility study, the HSE announced that it would be using the database of licensed users of agricultural pesticides run by the National Proficiency Tests Council (NPTC) to study the health effects of pesticides. The feasibility study also found that 15% of users thought they had been made ill, or had an existing illness made worse, by exposure to pesticides at work. The most common symptoms were headaches.

## MAJOR ACCIDENTS

There is separate legislation to protect communities from major chemical accidents which, among other things, requires that chemical companies

producing dangerous substances in certain amounts draw up and test emergency plans. In February 1999, the former law, the Control of Industrial Major Accident Hazards Regulations 1984 (CIMAH), was replaced with the Control of Major Accident Hazards Regulations (COMAH). The legislation stems from the European Seveso directives, named after an Italian town which suffered the effects of a major accident at its chemical plant in 1976.

## TOXICS USE REDUCTION

A far more radical and precautionary approach to chemicals has been taken by the US State of Massachusetts. Instead of using risk assessment to control chemical hazards, their Toxics Use Reduction Act (TURA) encourages companies to redesign processes and plant to reduce use of toxic chemicals and generation of hazardous waste.

### **What is toxics use reduction?**

"Toxics use reduction means in-plant changes in production processes or raw materials that reduce, avoid or eliminate the use or generation of hazardous by-products per unit of product so as to reduce overall risks to the health of workers, consumers or the environment without shifting risks between workers, consumers or parts of the environment," The Massachusetts Toxic Use Reduction Program.

The law requires that any firm using more than a certain amount of any substance on a list of toxic and hazardous chemicals must report on its use, and pay a fee, to the State. In this way, the law pays for itself. These firms are also required to prepare, and regularly update, a plan on how they would reduce or eliminate use of the listed chemicals in their processes. Between 1990 and 1995, Massachusetts firms cut generation of hazardous waste by 30%, and reduced their use of toxic chemicals by 20% due to TURA. When the latest figures are analysed, the Massachusetts Toxic Use Reduction Program hopes to have met its goal to cut generation of hazardous waste by 50% by 1997.

The law has also saved firms money. Between 1990 and 1997, Massachusetts firms spent \$76.6 million complying with TURA, but gained \$90.5 million in savings in operating costs plus federal grants, so the law netted the firms nearly \$14 million even before workers' health and environmental benefits are taken into account.

Planning toxics use reduction (TUR) in a business involves a step-by-step process: 1, setting goals and priorities; 2, analysing the process; 3, identifying TUR options;\* 4, evaluating TUR options; 5, implementing TUR changes; and 6, measuring progress.

\*TUR techniques are: 1, chemical input substitution; 2, product reformulation; 3, production process changes; 4, process modernisation; 5, improvement in operations and maintenance; and 6, in-process recycling (*Massachusetts is cleaner & safer: report on the Toxics Use Reduction Program*, University of Massachusetts Lowell Toxics Use Reduction Institute, 1997; Toxics use reduction, *Hazards* 53, Winter 1995/1996, pp. 8–9; Sun goes down on toxics, *Hazards* 60, 1998, p. 4).

## CHEMICAL AGENTS DIRECTIVE

The EU's Chemical Agents Directive has to be implemented in the UK by May 2001. It covers health and safety hazards of chemicals, and although the health provisions largely mirror COSHH, new or amended legislation will be needed to implement the Directive's provisions on emergencies, fire and explosions.

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## **Other information**

The HSE has published a *Chemical Information Directory*, covering information on chemicals produced by the HSE, trade unions and industry groups. Information is listed by industry sector as well as chemical group, and the intended audience of each publication is given. The directory became available at the end of 1998, and is free.

## 4

## PREVENTION AND CONTROL OF CHEMICAL HAZARDS

There are many ways of ensuring that workers are not exposed to hazardous substances at work. Preventing exposure is at the top of the hierarchy of controls laid out in the COSHH Regulations, and personal protective equipment (PPE) very definitely at the bottom. Regulation 7 of COSHH says, "So far as is reasonably practicable, the prevention or adequate control of exposure of employees to a substance to health, except to a carcinogen or a biological agent, shall be secured by measures other than the provision of personal protective equipment." The General Acop goes on, "For all hazardous substances, the employer must give first priority to trying to prevent exposure." Preventing exposure can be achieved by changing the process so the substance is no longer used or generated or by substitution with a substance of no or lower risk. Unfortunately, although some legislators and employers take preventing, as opposed to controlling, exposure seriously, too many UK workers still have to rely on PPE to control exposure to chemicals.

### SUBSTITUTION

One means of preventing exposure is substitution with a safer chemical. There are several UK and European examples of this approach, in both individual workplaces, and across whole industries, such as the SUBSPRINT project. SUBSPRINT was a European project set up in 1991 to extend Danish printers' success in substituting organic solvents with vegetable oil cleaning agents (VCAs) for wash-up in offset printing presses. However, SUBSPRINT was more successful in certain parts of Europe, with smaller nations like Iceland getting over half (55%) of their presses running with VCAs, but larger countries like the UK only achieving a 2–10% switch. SUBSPRINT's final report says, "It is debatable how much real and lasting substitution there will ever be in the UK without strong environmental and health and safety laws plus rigorous enforcement that affects even small and medium sized printing companies" (*SUBSPRINT Final report*,

Kooperationsstelle Hamburg, 1997). More could have been achieved, says Bud Hudspith of the GPMU, if the project had been better funded in the UK (as happened in Germany), if suppliers had been more supportive, and if the HSE had "got on board, instead of sitting on the fence."

As well as worker health and safety, SUBSPRINT was driven by environmental concerns. Printing is a major user of organic solvents. Many of these are volatile, and as much as 290 million litres of volatile organic compounds (VOCs) are emitted from EU printers each year, making it the second biggest industrial source of VOCs in Europe. VOCs cause environmental problems because they damage the ozone layer. Although the use of VOCs in printing is an example of substitution that benefits worker health and safety as well as the environment, others do not.

#### **Worker health and safety versus the environment?**

Because of concern about the ozone layer, many chlorinated organic solvents were banned under the 1987 Montreal Protocol. One of the solvents phased out was 1,1,1-trichloroethane, which was widely used by small engineering companies in metal degreasing. Many of these companies replaced 1,1,1-trichloroethane with trichloroethylene (trike), simply because they had used it in the past. However, trike is more acutely toxic and carcinogenic, and has a significantly lower occupational exposure limit than 1,1,1-trichloroethane. With a bit more thought, the degreasers could have switched to aqueous cleaning, or changed the process to avoid cleaning altogether (B. Allen, *Solvents: the hidden abuse*, *Occupational Health Review*, 1996, 64, 17). In Massachusetts, the TUR Act specifically says that substitution is not about "shifting risks between workers, consumers or parts of the environment."

A 1994 survey of degreasers by the HSE found 41% had recently changed to trike because of the Montreal Protocol. 39% of these new trike users had not reviewed (or ever done) their COSHH assessments, and only 37% were doing adequate air sampling for trike.

The Montreal Protocol also banned CFC-114, which was used as a refrigerant. In one Belgian smelting plant, CFC-114 was replaced with an HCFC mixture in the air-conditioning unit of an overhead gantry cabin. After nine gantry drivers developed hepatitis, an occupational health doctor traced the cause to the new, more environmentally friendly coolant. The new mixture contained HCFC-123, which had already been found to cause liver

damage in rats. The drivers had been exposed to HCFC-123 at levels much higher than the occupational exposure limit because of a leaking hose in the air-conditioning system. The problem might have been noticed sooner if someone had realised that the unit must have been leaking because it needed to be refilled so often (*Chemical and Engineering News*, 25 August 1997, p. 8).

## Just transition

Another nettle being grasped in the USA is the impact on jobs that could result from phasing out environmentally damaging chemicals. Using the expression "just transition", unions such as the Oil, Chemical and Atomic Workers' International Union (OCAW), are negotiating deals with employers for retraining, or continued pay until retirement or alternative work is found (*Workers' Health International Newsletter*, Jan-June 1998, issue 53, p. 10). According to Joel Tickner of the Massachusetts Toxic Use Reduction Program, however, there is no evidence of job losses due to improved environmental legislation. Instead, Tickner says, the threat, to both jobs and worker health and safety, is from migration of the chemical industry to less developed countries.

## CONTROLS

Regulation 7 of the COSHH Regulations sets out the controls that should be used if prevention is not "reasonably practicable". For non-carcinogens, the General Acop says, "adequate control of exposure should be achieved by measures other than personal protective equipment, so far as is reasonably practicable..." These controls include enclosing the process, partial enclosure with local exhaust ventilation, local exhaust ventilation, sufficient general ventilation, reducing number of employees exposed, reducing the period of exposure, regular cleaning, safe storage and disposal, prohibiting eating, drinking and smoking in contaminated areas, and providing adequate washing, changing and laundering facilities.

## Ventilation

There are several types of ventilation systems, including natural ventilation, general mechanical ventilation and local exhaust ventilation.

Natural ventilation, such as simply opening doors and windows, should never be relied on to control exposure to chemicals, as several case studies in this book show. General mechanical ventilation is suitable for only the

most innocuous substances. This type of ventilation involves a fan to extract air from the building and an inlet to suck clean air back in, and merely dilutes the amount of chemicals in the workplace air. To be effective, general ventilation needs to be carefully designed, otherwise there may be areas left with no air circulation (dead zones). This was one of the problems in Brian Harris's photographic department (see p 33).

Local exhaust ventilation (LEV) attempts to extract hazardous chemicals at the point they are released, before they get into workplace atmosphere and the breathing zone of workers. There are many different types of LEV, including fume cupboards, booths, and hoods, and they too must be very carefully designed.

The exhaust air from these ventilation systems also needs to be properly treated to remove the chemicals, especially if the same air is recycled into the working environment. Like the design of other parts of the ventilation system, air treatment methods must be carefully chosen, depending on the type of chemicals involved. Ventilation systems must also be regularly checked and maintained. Regulation 9 of COSHH says, "Every employer who provides any control measure to meet the requirement of Regulation 7 shall ensure that it is maintained in an efficient state, in efficient working order and in good repair and, in the case of personal protective equipment, in a clean condition. Where engineering controls are provided to meet the requirements of Regulation 7, the employer shall ensure that thorough examinations and tests of those engineering controls are carried out – in the case of local exhaust ventilation plant, at least once every 14 months..."

### **Darkroom disease**

The Society of Radiographers (SoR) has campaigned for "darkroom disease" to be recognised as an occupational illness since 1982, but had to wait until 1995 for a successful court judgement. In the past 15 years, 12 SoR members have received a total of £577,000 compensation. All but one of the cases were settled out of court. Individual settlements ranged from £10,000 to £135,000, and the SoR currently has 12 cases in progress. According to the SoR, "As long as the Department of Health continues to fight cases instead of improving working conditions, we will continue to see employers addressing complaints with haphazard and makeshift changes which are ineffective and expensive."

David Ogden worked as a radiographer at Airedale Hospital from 1979, but in 1991 his doctor advised him to give up work as a radiographer.

Since 1987 he had suffered attacks of breathlessness severe enough for him to be admitted to hospital. In 1995, a Sheffield Court found Airedale Health Authority guilty of negligence and awarded Mr Ogden £62,000. He has since had to retrain as an occupational therapist.

During the court case it emerged that the hospital had ignored advice from their own consultants to install ventilation in one of the X-ray areas. In the same year, 1987, several radiographers at the hospital reported persistent cold-like symptoms, sore eyes and laryngitis. Despite this, staff were not given protective equipment, and the hospital did not monitor fume levels or staff, warn them about the hazards of the chemicals they used, or implement procedures for dealing with spills. Even during the trial, the hospital still had not produced a COSHH assessment for the X-ray areas.

The judge said that by 1985 the hospital "knew or ought to have known that some of these irritant chemicals were, or might well be, sensitisers ...[and] by 1987 the symptoms of which the radiography staff were complaining made it as plain as a pikestaff that chemical fumes were having an irritant effect on staff's eyes and respiratory tract."

The judge decided that Ogden was indeed suffering from occupational asthma, having been being sensitised to X-ray chemicals at work, and that the sensitisation was due to the hospital's negligence. He said the hospital's failure to protect Mr Ogden "against exposure by providing exhaust ventilation, warnings as to the dangers and/or protective equipment was in my judgement plainly negligent." The judge said that for want of inexpensive precautions by the hospital, Mr Ogden's career as a radiographer had been ended.

By 1991 the SoR had become so concerned about the number of its members reporting symptoms of "darkroom disease" that it decided to do a survey. Over 2,800 (almost a quarter of the SoR's members) responded. The survey found large numbers of radiographers suffering from symptoms associated with darkroom disease. Over two-thirds of respondents had noticed a processor problem, showing that fumes were being released, and over a third of the departments had no fume control or ventilation system whatsoever. According to the SoR, "Unfortunately, the research shows that the legal requirements of COSHH were not met in X-ray departments, and continue to be inadequately implemented. Over 85% of departments responding to the survey broke the law requiring risk assessments and 38% continue to do so."

The SoR repeated the survey in 1997. Although fewer respondents were suffering from symptoms, there was a small increase in the number of radiographers reporting chemical smells or crystal deposits in the processing area, tell tale signs of fumes escaping from the processor. According to the SoR, "This last area has serious implications, as a leak must have been very long standing, and maintenance irregular, for crystals to have developed."

Several factors could be responsible for the increased reporting of darkroom disease since the 1980s, including changes in X-ray processing methods. There was a move to automatic processing, which runs at higher temperatures, and silver is being recovered from processing waste. X-ray film processing fumes contain over a dozen different chemicals. Most of these have occupational exposure limits, but when workers are exposed to cocktails of chemicals, they may cause more damage together than on their own. The SoR explains this – synergism – as "the chemical equivalent of trade unionism, where the effects of the chemicals together are greater than the sum of the parts. However, in the case of chemicals, the effects of combination are far from beneficial for workers" (*Preventing the darkroom disease: health effects of toxic fumes produced in x-ray film processing*, Society of Radiographers, 1991; *Synergy*, November 1997 p. 12).

## PERSONAL PROTECTIVE EQUIPMENT

In its guidance to the Personal Protective Equipment at Work Regulations, the HSE says, "PPE should always be regarded as the 'last resort' to protect against risks to safety and health; engineering controls and safe systems of work should always be considered first."

"The principle that PPE should always be regarded as the last in the line of defence when protecting people against exposure to hazardous chemicals is often quoted but, unfortunately, not often followed ... Often the quickest and cheapest solution to a chemical exposure problem is to consider PPE as the first, and possibly the only, option," P. J. Turnbull in Lewis.

An effective PPE programme should be based on risk assessment and the PPE should be correctly selected, correctly fitted, given to workers only after training in why it is needed and how to use it, and correctly maintained and disposed of. PPE for chemical exposures is covered by COSHH

Regulations 7–9. In situations outside the scope of COSHH or other Regulations (such as those on lead and asbestos), PPE is covered by the Personal Protective Equipment at Work Regulations 1992. However, according to the guidance on PPE Regulations, “Even if the PPE at Work Regulations do not apply, the advice given in this guidance may still be applicable, as the general principles of selecting and maintaining suitable PPE and training employees in its use are common to all Regulations which refer to PPE.” All PPE bought and sold in the European Union must carry a ‘CE’ mark, to certify that it has passed a required set of tests.

The shortcomings of PPE must be stressed. All too often it is not tested, not suitable, not effective, not durable and not maintained.

## **Respiratory protective equipment**

There are many types of respiratory protective equipment (RPE) available. This can make selecting the correct type a complicated business, but it is vital that the right equipment is used, because different types of RPE only give protection against specific types of chemicals. There are two main groups: respirators, which filter substances from the air, and equipment which supplies clean air to the worker.

Respirators trap chemical contaminants in a filter before they can be breathed in. Because they do not supply oxygen, they must never be used in oxygen-deficient atmospheres. Choice of filter is also crucial, as different filters offer protection against only certain chemicals. The most efficient particle filters are the hardest to breathe through, and as a result are uncomfortable to wear. However, powered respirators are also available. Wearing RPE is hard work, and can reduce heat loss from the body, so tasks involving RPE need to be designed with this in mind. Respirators are also not effective if they leak, so they must be chosen to fit an individual worker’s face correctly, for example to take account of a worker’s spectacles or beard.

## **Breathing apparatus**

The second type of RPE supplies clean air to the wearer through an airline or from a compressed-air cylinder. The simplest type is compressed air-line equipment, whereas self-contained breathing apparatus gives the highest level of respiratory protection and is the type used by emergency services. An HSE guide gives detailed guidance on selecting the correct RPE, which says that several factors should be considered. These include whether the atmosphere contains enough oxygen, the substances present, the properties

and toxic effects of the substances, the levels they are present at, and their occupational exposure limits.

As well as deciding whether to use a respirator or breathing apparatus, the minimum protection required (MPR) should be calculated ( $\text{MPR} = \text{workplace concentration outside the facepiece of the RPE} / \text{maximum allowable concentration inside the facepiece}$ ). The MPR should then be compared with the assigned protection factor (APF) of various types of RPE, published in British Standards, although APFs are a rough guide, not a hard and fast rule. The nominal protection factor (NPF) used in the past is no longer valid.

The HSE guide also covers work-related factors which should be considered when selecting RPE, including the physical demands of the job, the impact of reduced visibility, compatibility with other PPE, and the need to be able to communicate with other workers. Given that the correct RPE is selected, it will only protect workers if they are trained in how and why to use it, and unless the equipment is properly maintained. According to the HSE, "Even the best equipment is unlikely to provide protection if wearers do not know how to use it properly. Similarly, protection will be affected if the RPE is not adequately maintained, or stored badly. You must provide training for your employees on how to use the equipment, before it is first put into service, and provide facilities for its storage and maintenance. In fact, everyone involved in a RPE programme must be trained. Users, managers and supervisors, and maintenance staff all need to understand their own role in the system."

RPE should always be checked before being worn, and effective maintenance is required by COSHH. RPE should also be stored correctly so that it is not damaged by heat, cold, damp or chemicals, and decontamination facilities are needed for certain substances like lead, asbestos, carcinogens, radioactive substances and pathogens. Finally, old RPE and filters must be correctly disposed of, including making sure they cannot be re-used.

## Gloves

Just like RPE, gloves are useless (or worse than useless) unless correctly chosen for the job in hand. Many types of glove are available, including natural rubber, nitrile, viton and butyl rubber gloves, and the skin protection they afford depends on the kind of chemical being used. Different glove materials will only resist certain types of chemical.

Damaged gloves obviously stop protecting the skin from chemicals, but

they can also increase the harm that the chemical can do by trapping it close to the skin, which is often sweaty and so more likely to absorb some substances. Glove damage, such as tears and holes, may not always be visible. Gloves can also become brittle if they are old, or may be rotted by chemicals, and this kind of damage also means they do not protect the skin. Care should also be taken to put gloves on and take them off correctly, so that the inside of one glove is not contaminated by contact with the outside of the other.

Latex gloves, used by health care workers, hairdressers, vets, dentists and electronics industry workers, are a common cause of allergic skin reactions. A 1997 study of 7,346 health care workers found 47.5% of workers on wards and 37.5% of theatre staff said that they had reacted to latex gloves. Theatres tend to use non-powdered surgical gloves, which cause fewer problems. Reactions to latex include irritation, delayed hypersensitivity, swollen, red and itchy hands or arms 6–48 hours after contact, and immediate hypersensitivity, nettle rash, runny nose, itchy eyes and asthma (G. Johnson, *Time to take the gloves off? Occupational Health*, October 1997, pp. 25–28).

## STORAGE

As well as being correctly used, chemicals must be stored properly. Guidance on storage can be found in safety data sheets, labels and HSE guidance, and storage requirements depend on the hazards of the chemical (such as its flammability) and amounts stored on site. Because certain substances react violently together, they should not be stored in the same place. Workers involved in chemical stores must be properly trained; in particular they must know how to handle spills, and have access to PPE and information on the chemicals in store. Emergency plans should include a list of substances in store, fire detection and control systems, training workers to use fire extinguishers, an evacuation procedure, correct safety signs on the store, and notifying the HSE and fire brigade if over 25 tonnes of a dangerous substance are stored on site.

If chemicals are kept in bulk tanks, they must be made of materials suitable for the chemical inside, protected from being hit by vehicles, fitted with signs showing the contents and hazards, fitted with gauges or alarms to stop them being overfilled, regularly inspected, and banded to contain leaks and spills (unless tanks contain LPG or similar substances). In addition, flammable liquid tanks should be outside and kept away from sources of ignition, including electrical equipment. Chemicals kept in packages (drums, kegs or

bags) should be stored in a non-combustible building, and packages should not be allowed into the store unless they are correctly labelled and have been checked for damage.

## BIOLOGICAL MONITORING

Biological monitoring is the measurement of the amount of a substance or its metabolite, or a biochemical effect, from which exposure can be assessed. Unlike atmospheric monitoring, biological monitoring measures the amount of a substance that has been absorbed into the body, rather than measuring the amount that is present in the workplace air.

A variety of specimens can be used, such as urine, blood or exhaled air. For example, exposure to an organophosphate pesticide can be monitored either by measuring the amount of a metabolite in urine, or by measuring the activity of an enzyme (acetylcholinesterase) in the blood. Workplace exposure to over 100 different chemicals can be estimated by biological monitoring.

Health surveillance, which includes biological monitoring, is a collective term for a variety of procedures designed to protect workers' health by early identification of exposure or disease. As well as biological monitoring, health surveillance includes biological effect monitoring, medical surveillance, examinations, and inspections and review of records.

Health surveillance should be triggered by the risk assessment process. The legal framework is covered by COSHH Regulation 11 and the Management of Health and Safety at Work Regulations 1992. However, research carried out by the Institute for Employment Studies for the HSE found that only one-third of employers with workers at significant risk from workplace hazards carried out health surveillance, and that many employers were confused about whether health surveillance was necessary (S. Honey, "Health surveillance in Great Britain", *Occupational Health Rev.*, 1997, 69, 14-18).

## SAFE SYSTEMS OF WORK

Formal written systems known as "permit-to-work systems" are used to control certain types of hazardous work. The permit-to-work document lists work to be done together with the necessary precautions. Permits-to-work are a vital part in safe systems of work for many maintenance activities. The HSE says, "A third of all accidents in the chemical industry were maintenance-related, the largest single cause being a lack of, or deficiency in, permit-to-work systems."

## FIRST AID

The Health and Safety (First Aid) Regulations 1981 set out employers' legal duties on first aid at work. A new Acop published in 1997 sets out minimum first-aid requirements, but no longer specifies the ratio of first aiders to employees. Instead, employers are expected to work out how many first aiders there should be in a particular workplace after doing an assessment of first-aid needs.

The Acop says the number of first aiders will depend on the level of risk in the workplace, and in some situations (low-risk workplaces or small companies) an employer can simply have an "appointed person" to be responsible for first-aid arrangements. The appointed person must not give first aid, but the HSE guidance recommends that employers consider emergency first-aid training for appointed persons.

First aiders must hold valid certificates from an organisation approved by the HSE and need to attend a refresher course every three years. Employers might also need to provide additional training, such as working in confined spaces or with certain chemicals.

The employer must tell workers what provisions have been made for first aid, and there must also be a record book for incidents where first aid has been administered. On shared sites, the HSE suggests that one employer should take overall responsibility for first aid, and it strongly advises that this should be spelled out in a written agreement (*First aid at work. The Health and Safety (First Aid) Regulations 1981. Approved Code of Practice and guidance.* ISBN 0 7176 1050 0).

## SAFETY REPRESENTATIVES

There are over 200,000 safety reps in Britain, and research has found that workplaces with safety reps are safer than those without them. Analysis of accident figures by the TUC in 1995 found a rate of 10.9 injuries per 1000 workers in workplaces without representation or consultation, compared with 5.3 injuries per 1000 workers in workplaces where there were union safety reps and joint safety committees.

"Union safety reps save lives and improve health and safety at work ... New laws are needed to cater for workers without a recognised trade union and to deal with smaller, more decentralised workplaces with fewer management resources for health and safety" (Hazards 52, Autumn 1995, p. 8, 9, 12).

### Substituting solvent-based paints

The best means of controlling exposure to a hazardous substance is to remove it from the workplace, and use something safer. It sounds simple, but as some painters have found, arguing the case for switching from solvent- to water-based paints is not always easy.

Painter and UCATT safety rep Peter Farrell has spearheaded substitution campaigns in two north London councils. This is his advice.

While working for Camden Council in the early 1990s, someone showed Peter a copy of newspaper cutting that worried him. The story was about a report from the International Agency for Research on Cancer that linked working as a painter with an increased risk of developing cancer, particularly lung cancer. IARC said, "Occupational exposure as a painter is carcinogenic (Group 1)."

Peter began looking for more information, and with the help of the London Hazards Centre and Camden Occupational Health Project found plenty. Peter remembers, "I got information from all sorts of sources, including a report of two Japanese painters who had died after using eggshell paint in enclosed premises, and another from the United States, much along the lines of the IARC report, which came to much the same conclusions."

He also gained heart from Danish colleagues after travelling to Denmark for an international safety reps conference. Concerned about the neurological effects of solvent-based paints, Danish unions had already campaigned against them, and by 1987 over 90% of construction paints used in Denmark were water-based. Peter says, "Having visited Denmark and seen the quality of their paints 15 years on, I couldn't tell the difference between water- and solvent-based paints, and in the Scandinavian countries they have retrained their painters to use these products, which have a different feel."

But back in Camden, Peter was having trouble convincing management to tackle the issue. "We had handed out some leaflets before, but things dragged on, so we decide to take some action," he says. Council painters met and demanded a ban on eggshell plus a phase-out of gloss paint.

As well as convincing the Council, Peter had also had to win over some of the painters. While the Council had been mainly concerned about the cost of substitution, some painters worried that they would be harder to use. Peter says, "Oil-based paint allows you to bodge things. Water-

based paints won't allow you to paint over dirt and grease – you have to do your preparation right. I think it's a small price to pay for your health." Other advantages of water-based paints are that they dry faster, brushes last longer and, because they are less hazardous, joinery can be painted before it leaves the joinery shop.

When he joined Islington Council in 1994 they were still using solvent-based paints, so Peter started campaigning all over again. This time management were much more receptive. Peter says, "By that time I had mountains of information, and just took out the most relevant. Because they were so far behind with their COSHH assessments, they realised they had to sort themselves out, so we got agreement from management, which we had never had at Camden." Peter had to counter all the old arguments about cost and durability, but feels these issues would be much easier to deal with if surveyors and architects were more aware of the hazards of solvent-based paints. "One of the biggest stumbling blocks has always been surveyors and architects, who do not like being told what to do by the shop floor. We never sit on the same bodies, and never see them at safety meetings [where at least we] could try to educate them. They are not being affected by these paints, so they don't think about the consequences of what they are specifying."

#### UCATT's surveys

Also as a result of the IARC report, in 1991 UCATT published the results of a survey of over 250 painters. It found that 93% reported health effects which they thought were due to solvent-based paints. The most common health effects were headaches, giddiness, nausea and running eyes or nose.

The union launched a national campaign for substitution. It said, "The first priority is to see all solvent-based paints replaced by water-based paints throughout the construction industry ... For the most part there remains little excuse for manufacturers and employers to continue to insist on using potentially hazardous solvent-based paints." Their second priority, as Peter has highlighted, was to get clients, architects and designers to start thinking about the health hazards of the materials they were specifying.

UCATT also negotiated a tripartite statement of intent with the Paintmakers Association and the National Federation of Painting and Decorating Contractors. Published in 1991, it said they would educate architects and contractors, publish safety information on correct use of

all decorative paints, publish a summary of manufacturers' alternatives to solvent-based products, promote substitution over ventilation or personal protective equipment, and develop and promote alternative paint technologies.

A 1998 UCATT safety survey asked:

Have you been involved in negotiating any changes in the use of hazardous substances, for example changing to water-based paints?

Yes 24% No 76%

Have you had any problems finding out information on the chemicals you work with? Regularly 13% Occasionally 37% No, we are given good information 50%

Does your employer provide on-site training on the risks of hazardous substances and their health effects? Yes 35% No 65%.

More needs to be done. Although water-based products now account for almost 70% of the UK retail trade in decorative paints, their use has increased little since 1992 according to the British Coatings Federation. In 1992 water-based paints accounted for 68.3% of the market, and in 1997 68.6% (*Some organic solvents, resin monomers and related compounds, pigments and occupational exposures in paint manufacturer and painting*, IARC 1989; M. K. Hansen et al, *Waterborne paints: a review of their chemistry and toxicology and the results of determinations made during their use*, *Scandinavian Journal of Work, Environment and Health* 1987, 13, 473-485).

The Safety Representatives and Safety Committees (SRSC) Regulations 1977 give recognised trade unions the legal right to appoint safety reps. Union safety reps appointed under the SRSC Regulations have important legal rights, including investigating potential hazards, investigating complaints, carrying out inspections, representing workers, receiving information, and attending safety committee meetings.

New regulations came into force in October 1996 covering health and safety consultation rights of non-union members. The Health and Safety (Consultation with Employees) Regulations 1996 were introduced because European legislation required that all workers be consulted on health and safety, not only union members as provided for by the SRSC Regs. The Health and Safety (Consultation with Employees) Regulations 1996 made no major changes to the SRSC Regs, but mean that employers have to consult with non-union members on health and safety either directly or via

an elected representative. These representatives, however, have fewer rights than union safety reps. Most importantly, they cannot carry out workplace inspections, follow-up reportable accidents, or investigate workers' complaints (Consultation rights for non-union workers, *Occupational Health Rev.*, 1996, 63, 3).

An important group without safety reps under the SRSC Regs are agricultural workers. Very few have access to safety reps because the Regs say unions must be recognised by employers for safety reps to be elected. Alongside construction, agriculture has the worst safety record in the UK, and the TGWU has been pressing government and the HSE to make provisions for the appointment of "roving safety reps". A pilot roving safety reps scheme was praised by an independent review published by the HSE in 1997. It said, "The representatives' achievements in awareness raising and liaison have been considerable given ... the absence of support from the influential NFU" (The role of regional health and safety representatives in agriculture: an evaluation of a trade union initiative on roving safety representatives in agriculture, contract research report no. 157/97, HSE, 1997; B. Allen, Roving safety reps praised by HSE-funded study, *Occupational Health Rev.*, 1997, 69, 6; D. Walters, Roving safety representatives, *Health and Safety Bull.*, 1997, 263, 13–15).

Workers who stop the job because of unsafe working conditions are protected by the Trade Union Reform and Employment Rights Act 1993. Under the Act, dismissal is automatically unfair if workers are dismissed for leaving the workplace or refusing to return in the event of serious and imminent danger, or for taking steps to protect themselves in such circumstances.

The law applies regardless of length of service. The first person to use it was a UCATT member who won £8,760 compensation at an industrial tribunal after being sacked when he called in HSE inspectors because he had been forced to work with wet wood treated with the chemical lindane (*Safety reps in action*, Labour Research Department, 1998).

However, it has to be borne in mind that recourse to a tribunal is a very limited remedy and there can be no guarantee of the outcome. Anyone faced with imminent danger should, if the circumstances allow, seek advice from their trade union before deciding on their course of action.

Further protection for safety reps against detrimental action by their employers is afforded by the Employment Rights Act 1996 and the Employment Relations Act 1999.

## ENFORCEMENT AUTHORITIES

Health and safety legislation is enforced by the HSE and by local authorities. The main areas of local authority enforcement are the retail and wholesale sectors, hotels and catering, offices, residential care homes, and the consumer/leisure service industry. The HSE is responsible for the remainder of workplaces. The HSE also works closely with the Environment Agency (EA). Two memorandums of understanding between the HSE and EA cover each organisation's regulatory responsibilities for licensed nuclear sites and radioactive substances at non-nuclear sites.

Local authority and HSE inspectors are entitled to carry out inspections of premises, to issue Improvement Notices which oblige employers to modify processes or work methods, to issue Prohibition Notices which oblige employers to cease carrying out dangerous activities, and to bring prosecutions. Inspectors are encouraged to liaise with trade unions and safety reps, e.g. by notifying them of the intention to visit premises. The extent to which this occurs in practice varies widely from inspector to inspector. However, safety reps should identify the inspectors responsible for their premises and make their acquaintance.

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## TAKING ACTION – ISSUES AND ORGANISATIONS

### TUC

One of the TUC's current campaigns on chemicals concerns the safe handling of solvents. A survey of 219 safety reps during 1998 found that workers were not being protected from solvents, largely because employers were still failing to comply with COSHH. Particularly worrying was the finding that many employers were relying on personal protective equipment (PPE) as a first line of defence, the opposite of what COSHH requires. Problems are most acute in small firms. The TUC has sent the HSE a list of recommendations based on its findings.

The TUC survey found marked differences in COSHH compliance between small and large firms. Only 47% of safety representatives in small firms reported that COSHH assessments had been done, compared with 68% in firms with over 100 employees. One in eight safety representatives said that their employer had been subject to some form of enforcement action by the HSE or local authority for breaches of COSHH.

Safety representatives reported that the most common means of controlling exposure to solvents was with PPE. 65% reported use of PPE, whereas only 42% said that elimination or substitution was used to control solvent exposure, the methods at the top of the hierarchy of controls in COSHH.

The TUC report says, "The general approach to controlling solvent risks, where this is happening at all, seems to be the opposite of what is required by the legislation, and the TUC believes that the HSE has a major educative task to perform."

On access to information and training, another requirement of COSHH, the survey found comparatively good access to safety data sheets (SDS) but low levels of training. 70% of safety representatives said they had access to SDSs for the solvents used at work, but 42% said that employees in their workplaces had not received training in safe handling of solvents.

The survey also asked safety representatives about health effects and monitoring. Skin irritation was reported in 27% of workplaces, but only 35% of safety representatives said that their employers were monitoring employees' health. Only 30% reported atmospheric monitoring of solvent levels. The TUC describes the lack of monitoring as "troubling" and believes that "far more attention needs to be paid to monitoring the ill-health effects on the workforce of employment." It would also like to see much more use of "body mapping."

As a result of the survey the TUC has asked the HSE to raise awareness that PPE is a last resort, not the first choice, in controlling exposure to solvents, ensure that employers understand their duty under COSHH to train workers, and encourage small firms to assess solvent risks and provide SDSs to workers [Masking the problem, TUC, 1998, is available from the Organisation and Services Department, TUC, Congress House, Great Russell Street, London WC1B 3LS (enclose a large, stamped, addressed envelope)].

## UNISON ACTS AGAINST LINDANE

UNISON has been campaigning for a ban on the pesticide lindane since 1995. Although now national UNISON policy, the action has been driven by the East Midlands region after local officers saw a Channel 4 Dispatches documentary. The programme investigated possible links between breast cancer clusters and use of lindane on sugar beet crops. Officers in the East Midlands were particularly concerned because the region includes Lincolnshire, a major beet-producing area.

The campaign has raised awareness of the issue though motions at the national women's and national UNISON conferences, and has made effective use of links with a range of other groups. Working with the Pesticides Trust, Women's Environmental Network, Green Network and Breast Cancer Coalition has made it easier for UNISON to widen the campaign from the UK to Europe.

Over 80 MPs signed an Early Day Motion in the House of Commons in May 1998 which said, "That this House draws attention to the ever-growing campaign to ban lindane; acknowledges that lindane, an organochlorine pesticide, is still used in the United Kingdom despite being banned in many European and other countries because of its link with breast cancer; and calls upon the Government to investigate further the use of lindane with a view to banning it as soon as possible."

For further information contact Jill Day, Unison East Midlands, 15 Castle Gate, Nottingham NG1 6BY; tel 0115 956 7200, fax 0115 956 7222.

## BECTU TACKLES MDF

BECTU, the Broadcasting, Entertainment, Cinematograph and Theatre Union, has lead a concerted and successful campaign to tackle the hazards of medium-density fibre board (MDF). BECTU has been concerned for some time about members who work with MDF and softwood dust without adequate dust extraction. As well as the materials they work with, BECTU members are particularly at risk because their workplaces are often stage sets which have not been designed with exhaust ventilation in mind, and because of casualisation in employment.

Maximum Exposure Limits apply to wood dust and formaldehyde (a component of MDF). Exposure to both hard- and soft-wood dusts can cause occupational asthma and cancer. Increased incidence of nasal cancer was reported in English furniture makers many years ago. Nasal cancer has been associated with hard- and soft-woods, although the risk is greater from hard woods. Both BECTU and UCATT urge their members to report any breathing problems, sore eyes or dermatitis. The HSE is currently reviewing the scientific literature on health effects of MDF.

Although they disagree about the hazards of MDF itself, BECTU and the Wood Panel Industries Federation (WPIF) have been able to work together to get employers in the industry to follow the COSHH Regulations. In 1998 they drafted a new leaflet on how to avoid the health risks of wood dust.

The campaign has also had wider benefits, according to Jane Paul, BECTU's health and safety officer when the campaign was launched. "MDF has been a useful vehicle – a Trojan horse. It has raised awareness of other issues" (J. Turner, Breakthrough on MDF, *Stage Screen and Radio*, February 1998, pp. 8–9; J. Turner, MDF: the asbestos of the '90s, *Stage Screen and Radio*, October 1997, pp. 10–12; The hazards of MDF wood dust and wood-based boards, UCATT safety briefing, Winter 1997).

## TGWU ON PESTICIDES AND ECO-AUDITING

TGWU members are involved in the production, transport and use of pesticides, and the union has a long history of campaigning for reduction in the use of pesticides. The TGWU organised a conference on pesticide

production, use and protection in 1997. In the report, the TGWU national secretary for agriculture says, "The union has long been concerned about pesticide exposure ... In 1950, two young farmworkers died after spraying a field with the weedkiller DNOC. One died on the roadside near the farm and the other in hospital. [And] as early as 1947 the union secured substantial damages for the widow of a member who died from DNOC poisoning." General Secretary Bill Morris says, "We owe it to ourselves and the future of our country and the planet to find ways of reducing our use of pesticides. A national policy is long overdue."

The report calls for use of pesticides only when absolutely necessary, development and use of pesticide reduction techniques, more use of integrated crop management, more research on biological pest control, application of the precautionary principle to genetically modified crops, and greater government support for organic farming.

As part of the campaign, the TGWU is also conducting a survey of pesticide reduction methods (*Pesticide reduction*, TGWU, 1998).

The TGWU also has many members in the chemical industry, and has been active in promoting sound environmental management at work. The TGWU is supporting standards like the Eco-Management and Audit Scheme (EMAS). The union held a conference on eco-management in 1996, and a survey of 450 safety reps in 1995 found that 36% were already involved in environmental issues at work and 92% said they would like to be involved.

A lot of research has shown that to be successful, company environmental policies need the participation of workers. According to one study in Denmark by Professor Borge Lorentzen, "Ordinary employees possess knowledge and experiences from their daily work and from production processes which are very important when it comes to establishing efficient environmental protection."

The TGWU organises in five of the nine UK companies that gained EMAS accreditation in the scheme's first year. At the chemical firm Rhone-Poulenc the union has negotiated an agreement allowing safety reps the same rights on environmental issues as they have under the SRSC Regulations. The *T&G safety rep's handbook* and the TGWU report *Trade unionists and eco-auditing* give practical guidance on how safety reps can get involved.

## THE PESTICIDES TRUST

The Pesticides Trust, a UK charity, works on the health and environmental

effects of pesticides. The Trust's aims are to minimise pesticides hazards, promote effective regulation of pesticides, eliminate trade in hazardous pesticides, reduce pesticide use, and advocate sustainable alternatives to chemical pest control. The Trust has also taken over the work of PEGS, the support group for victims of pesticide poisoning.

The Pesticides Trust is the European centre of the Pesticides Action Network (PAN), which was set up in 1982 and now links over 300 organisations in 60 countries. Another of the regional centres, the Pesticide Action Network North America (PANNA) is currently campaigning to prevent the export of banned pesticides, promote organic cotton, and build coalitions to reduce pesticide use.

## **Cutting pesticide use in local authorities**

Local authorities are the biggest single users of pesticides outside farming. However, unlike farmers, local authorities apply pesticides to areas used by the public in large numbers. They are also politically accountable. A handful of local authorities have responded to local pressure, or taken the initiative, and tried to reduce use of pesticides on their land and buildings.

Brighton Council and the London Borough of Southwark are two local authorities to have joined the Pesticides Trust Local Authorities Project to develop and implement policies to change the way they and their contractors control pests on roads, in parks and buildings.

Both Brighton and Southwark say public pressure played a part in their decision to move away from chemical pest control. Brighton's pest management policy is Council-wide, and Southwark's covers its Education and Leisure Department. Chemicals are now only used in Southwark's parks when there is no other alternative, such as manual or biological control. They have also specified use of non-chemical pest control in all new council contracts. "That means that a contractor must bid for the contract on the understanding that work will be carried out without using pesticides," Southwark Council says.

In Brighton the pest management policy has applied council-wide since 1994. According to the policy's lead officer at the Council, Amelia Garman, "Pesticide usage has dropped... Where we wanted to remove some chemicals from use but no immediate practicable alternative was available, we developed compromise solutions; we put chemicals under review or limited their use to very specific areas and asked for experiments with alternatives to be run [that] could be used in the future."

Only 14 local authorities are members of the Pesticide Trust's scheme. Other authorities are keen, but the Trust says it has too few resources to promote the scheme further.

## HAZARDS CAMPAIGN CHARTER

The national Hazards Campaign was set up in 1988 and draws together local hazards centres, occupational health projects and specific issue-based campaigns such as asbestos support groups and toxic waste groups. The Hazards Campaign lobbies in the UK and Europe, and organises meetings and an annual conference.

The Campaign's *Hazards Charter* sets out an agenda for action. It says, "The Charter is neither revolutionary nor party political. It is radical only in the sense that it points out that at the end of the 20th century people in Britain are still dying from causes that could be stopped with knowledge, action and resources."

On chemicals, the Charter says, "The Hazards Campaign demands an urgent review of all substance control legislation to ensure the following: a ban on substances and processes using or generating substances where no safe practical exposure limit can be achieved, stricter enforcement of the requirement to use substitutes, mandatory penalties for failing to do risk assessments, stricter enforcement of requirements to provide adequate control, ventilation, or PPE, mandatory service of prohibition notices on employers for non-compliance, higher penalties for convicted offenders, suitable training for substance users, and more information for the public buying chemicals for domestic use, including provision of data sheets."

The Charter demands a ban on the pesticides lindane, pentachlorophenol, tributyltin oxide, and organophosphates, as well as right of public access to pesticide data. It also urges a total ban on asbestos, stricter standards for PPE and other safeguards for workers removing asbestos, and the establishment of a public register of buildings that contain asbestos (*Hazards Campaign Charter*, second edn., available from the Hazards Campaign, c/o Hazards '97 office, 47 Godwin Street, Bradford BD1 2SH).

## THE INTERNATIONAL PICTURE

As well as the UK regulatory bodies, which are responsible for implementing and enforcing health and safety legislation, Europe has been the driving force behind new UK legislation from the late 1980s onwards. As well as developing and passing legislation, the European Commission has set up two

agencies whose remits cover health and safety. These are the European Foundation for the Improvement of Living and Working Conditions in Dublin, and the European Agency for Health and Safety at Work in Bilbao.

The United Nations (UN) also has several agencies with an interest in health and safety, including the World Health Organisation (WHO), the International Labour Organisation (ILO) and the United Nations Environment Programme (UNEP). These agencies run the International Programme on Chemical Safety (IPCS), which assesses the risks of chemicals to both workers and the environment. IPCS publications include *Environmental Health Criteria*, *Health and Safety Guides*, *International Chemical Safety Cards*, *Poisons Information Monographs*, and *Pesticide Data Sheets*.

The IPCS has come under fire in recent years for being manipulated by the chemical industry (A. Watterson, Chemical hazards and public confidence, *Lancet*, 1993, 342, 131–132). Following the US National Institute for Occupational Safety and Health's decision not to participate in IPCS activities until it developed a more objective way of developing criteria documents, and the alleged over-involvement of scientists with close links to the asbestos industry in the drafting of the IPCS criteria document on chrysotile asbestos, 81 scientists wrote to the IPCS and the UN to complain [B. Castleman and R. Lemen, The manipulation of international scientific organisations, *International Journal of Occupational and Environmental Health*, 1998, 4(1), 53–55; Crooked science, *Hazards* 63, July/Sept 1998, 10].

Similar criticisms have been levelled against the International Commission on Occupational Health (ICOH). According to Dr Joseph LaDou, director of the International Center for Occupational Medicine at the University of California, "Many people present their ICOH membership as if the ICOH were an unbiased, independent, international consensus body, rather than a club whose members largely represent the private sector [J. LaDou, ICOH caught in the act, *Archives of Environmental Health*, 1998, 53(4), 247–248].

Established by the WHO in 1965 the International Agency for Research on Cancer (IARC) enjoys a rather better reputation. Based in Lyon, IARC co-ordinates and conducts research on the causes of human cancer. It has published over 70 monographs evaluating over 800 individual chemicals and mixtures, as well as occupational exposures.

## Toxic trade and Prior Informed Consent

In September 1998, 57 countries including the UK signed the Convention

on the Prior Informed Consent Procedure (PIC) for Certain Hazardous Chemicals and Pesticides in International Trade, or Rotterdam Convention for short. The convention is a legally binding treaty based on the voluntary PIC procedure that had been operated since 1989 by the United Nations Environment Programme (UNEP) and the Food and Agriculture Agency (FAO).

The Rotterdam Convention requires that hazardous chemicals and pesticides banned or severely restricted in at least two countries shall not be exported unless explicitly agreed by the importing country. If a government does choose to accept an import of a hazardous chemical or pesticide, the exporter will be obliged to provide extensive information on the chemical's potential health and environmental dangers.

UNEP says the Convention "will establish a first line of defence against future tragedies by preventing unwanted imports of dangerous chemicals, particularly in developing countries. By extending to all countries the ability to protect themselves against the risks of toxic substances, it will have 'levelled the playing field' and raised global standards for protection of human health and the environment. In short, the Convention will enable the world to monitor and control the trade in very dangerous substances."

According to UNEP Executive Director Dr. Klaus Töpfer, "With some 70,000 different chemicals on the market and 1,500 new ones being introduced every year, many governments are unable to monitor and manage the many potentially dangerous substances crossing their borders every day ... By shining a spotlight on the problem and setting up trade controls and information exchange procedures, this new treaty will help to save lives and reduce the poisoning of the environment."

The Rotterdam Convention covers 22 pesticides: 2,4,5-T, aldrin, captafol, chlordane, chlordimeform, chlorobenzilate, DDT, dieldrin, dinoseb, 1,2-dibromoethane (EDB), fluoroacetamide, HCH, heptachlor, hexachlorobenzene, lindane, pentachlorophenol and mercury compounds, and certain formulations of monocrotophos, methamidophos, phosphamidon, methyl parathion and parathion, and five industrial chemicals: crocidolite, polybrominated biphenyls (PBB), polychlorinated biphenyls (PCB), polychlorinated terphenyls (PCT) and tris-(2,3-dibromopropyl) phosphate. UNEP says that hundreds more are likely be added as the convention is implemented. Chemicals subject to the PIC procedure, and import decisions by country and chemical are published on the Internet (<http://chem.unep.ch/pic>).

# 6

## CONTACTS AND RESOURCES

### Hazards centres and occupational health projects

Birmingham Health and Safety Advice Centre (HASAC), Unit 304,  
The Argent Centre, 60 Frederick Street, Birmingham B1 3HS;  
Tel: 0121-236 0801

Bradford Occupational Health Project, 23 Harrogate Road, Bradford,  
South Yorkshire BD2 3DY; Tel: 01274-626 191

City Centre, 2nd floor, Sophia House, 32/35 Featherstone Street,  
London EC1 8QX; Tel: 0171-608 1338/9

Health and Safety Project, Trade Union Studies Information Unit,  
Mari House, Old Town Hall, Gateshead NE8 1HE; Tel: 0191-478 6611

Health Works at Newham, Alice Billings House, 2-12 West Ham Lane,  
London E15 4SF; Tel: 0181 557 6161;  
e-mail [chris.reeve@newham.gov.uk](mailto:chris.reeve@newham.gov.uk)

Hull and District Trades Union Council Action on Safety and Health  
(HASH), 231 Boulevard, Hull HU3 3EQ

Inverclyde Occupational Health Project, 175 Dalrymple Street,  
Greenock PA15 2IJ; Tel: 01475 888039

Keighley Worksafe Project, 136 Malsis Road, Keighley BD21 1RF;  
Tel: 01535-691 264; e-mail [ktuc@virgin.net](mailto:ktuc@virgin.net)

Leeds Occupational Health Project, 88 North Street, Leeds LS2 7PN;  
Tel: 0113-294 8222

Liverpool Occupational Health Project Street, c/o National Bank  
Buildings, 24 Fenwick Street, Liverpool L2 7NE; Tel: 0151-236 6008;  
[jb&ck@liverpool-ohp.demon.co.uk](mailto:jb&ck@liverpool-ohp.demon.co.uk)

London Hazards Centre, Interchange Studios, Dalby St,  
London NW5 3NQ; Tel: 0171-267 3387; mail@lhc.org.uk

Lothian Occupational Health Project, 26–28 Albany Street,  
Edinburgh EH1 3QH; Tel: 0131-57 9873

Lothian Trade Union and Community Resource Centre, Basement,  
26/28 Albany St, Edinburgh EH1 3QH; Tel: 0131-556 7318;  
e-mail: [LOTHIAN-TUCRC@geo2.poptel.org.uk](mailto:LOTHIAN-TUCRC@geo2.poptel.org.uk)

Manchester Hazards Centre, 23 New Mount Street,  
Manchester M4 4DE; Tel: 0161-953 4037

Rotherham Occupational Health Project, Room 9, Imperial Buildings,  
Corporation Street, Rotherham S60 1PA; Tel: 01709-820 472

Sheffield Occupational Health Project, Mudford's Building,  
37 Exchange Street, Sheffield S2 5TR; Tel: 0114-275 5760;  
e-mail [sheffieldoccupationalhealthproj@compuserve.com](mailto:sheffieldoccupationalhealthproj@compuserve.com)

South West Action on Safety and Health, 16 Woodwater Lane, Exeter,  
Devon EX 5LL

Walsall Action for Safety and Health, 7 Edinburgh Drive, Rushall,  
Walsall WS4 1HW; Tel: 01922 25860

## **Trade unions**

Trades Union Congress (TUC), Congress House, Great Russell Street,  
London WC1B 3LS; Tel: 0171-636 4030

Scottish TUC, Middleton House, 16 Woodlands Terrace,  
Glasgow G3 6DF; Tel: 0141 332 4946

Wales TUC, Transport House, 1 Cathedral Road, Cardiff CF1 9SD;  
Tel: 01222-372 345

Irish Congress of Trade Unions, 19 Raglan Road, Dublin 4, Ireland;  
Tel: 0001-081 680 641

Irish Congress of Trade Unions, Northern Ireland Committee,  
3 Wellington Park, Belfast BT9 6DJ; Tel: 01232-681 726

## **Enforcement agencies**

Enforcement is the responsibility of the Health and Safety Executive (HSE) and local authority environmental health departments.

HSE, National Information Centre, Broad Lane, Sheffield S3 7HQ;  
Tel: 0541 545500

## Other agencies with an interest in chemicals

Agency for Toxic Substances and Disease Registry (ATSDR),  
1600 Clifton Road, NE, MS E33, Atlanta, GA 30333, USA;  
tel: +1 404 639 5040; fax: +1 404 639 0560

Association of Personal Injury Lawyers (APIL), 10a Byard Lane,  
Nottingham, NG1 2GJ; tel: 0115-958 0585

British Occupational Hygiene Society, Suite 2, Georgian House, Great  
Northern Road, Derby DE1 1LT, tel: 01332 298101, fax: 01332 298099,  
email: 100705.3356@compuserve.com

Centre for Occupational and Environmental Health, De Montfort  
University, Scraptoft, Leicester LE7 9SU, tel: 0116 257 7736,  
fax: 0116 257 7708

Chemical Industries Association, Kings Buildings, Smith Square,  
London, tel: 0171 834 3399, fax: 0171 834 4469

Chemical Hazards Communication Society, PO Box 3687, Bracknell,  
Berkshire, RG42 2YT, tel: 7000 790 337, fax: 7000 790 338, email:  
CHCS@compuserve.com, web: <http://www.rsc.org/is/chcs/chcs.htm>

Environment Agency, Millbank Tower 25th Floor 21-24 Millbank  
London SW1P 4XL, tel: 0171 587 3000, fax: 0171 587 5258  
web: <http://www.environment-agency.gov.uk>

European Agency for Health and Safety at Work, Gran Via 33 E-48009,  
Bilbao, Spain, tel: +34 94 479 43 60, fax: +34 94 479 43 83,  
email: [information@eu-osha.es](mailto:information@eu-osha.es), web: <http://www.eu-osha.es/>

European Foundation for the Improvement of Living and Working  
Conditions, Wyattville Road, Loughlinstown, Co. Dublin, Ireland,  
tel: +353 1 204 3100, fax: +353 1 282 6456,  
web: <http://www.eurofound.ie>

International Agency for Research on Cancer (IARC), 150 cours Albert  
Thomas, F-69372 Lyon cedex 08, France, tel: +33 (0)4 72 73 84 85,  
fax: +33 (0)4 72 73 85 75

International Programme on Chemical Safety (IPCS)  
c/o WHO, Ch-1211 Geneva 27 Switzerland, tel: +41 22 791 2111,  
fax: +41 22 788 1949

International Register of Potentially Toxic Chemicals (IRPTC),  
UNEP/IRPTC, Palais Des Nations Ch-1211 Geneva 10 Switzerland,  
tel: +41 22 979 91 11, fax: +41 22 797 34 60, e-mail: [irptc@unep.ch](mailto:irptc@unep.ch)

Institute of Occupational Health, University of Birmingham, Edgbaston,  
Birmingham B15 2TT

Industrial Injuries Advisory Council, The Adelphi, 1-11 John Adam  
Street, London WC2N 6HT, tel: 0171 962 8066, fax: 0171 962 8852

Institution of Occupational Safety and Health, The Grange, Highfield  
Drive, Wigston, Leicestershire LE18 1NN, tel: 0116 257 3100,  
fax: 0116 257 3101, web: <http://www.iosh.co.uk>

National Asthma Campaign, Providence House, Providence Place,  
London N1 0NT, tel: 0171 226 2260, helpline: 0345 01 02 03,  
fax: 0171 704 0740

Pesticides Trust, Eurolink Centre, 49 Effra Road, London SW2 1BZ,  
tel: 0171 274 8895, fax: 0171 274 9084, e-mail: [pesttrust@gn.apc.org](mailto:pesttrust@gn.apc.org),  
web: <http://www.gn.apc.org/pesticidetrust>

Society of Occupational Medicine, 6 St Andrew's Place, London NW1  
4LB, tel: 0171 486 0028, email: [som@sococcm.demon.co.uk](mailto:som@sococcm.demon.co.uk)

SWORD, Department of Occupational and Environmental Medicine,  
National Heart and Lung Institute, Imperial College, Dovehouse Street,  
London SE3 6LY, tel: 0171 351 8934, fax: 0171 351 8091

Toxics Use Reduction Institute, University of Massachusetts Lowell,  
One University Avenue, Lowell, MA 01854-2866, tel: +1 978 934 3275,  
fax: +1 978 934 3050, web: <http://www.turi.org>

WATCH Secretariat (HSE), 6th Floor, South Wing, Rose Court,  
Southwark Bridge, London SE1 9HS

## **Chemical health and safety web resources**

Cornell University, combined archive of material safety data sheets,  
<http://MSDS.PDC.CORNELL.EDU/issearch/msdssrch.htm>

OSHWEB, links to chemical safety web resources,  
<http://www-iea.me.tut.fi/cgi-bin/wilma.pl/chesa>

National Toxicology Program, searchable list of chemical health & safety  
data, <http://ntp-server.niehs.nih.gov/>

Agency for Toxic Substances and Disease Registry ToxFAQs, summaries about hazardous substances, <http://atsdr1.atsdr.cdc.gov:8080/toxfaq.html>

IARC, lists of IARC evaluations, <http://193.51.164.11/monoeval/grlist.html>; <http://www.iarc.fr/>

EPA Enviro\$en\$e, Solvent Substitution Data Systems, <http://es.epa.gov/ssds/ssds.html>

The Extension TOXicology NETwork (EXTOXNET), pesticide information profiles and toxicology information briefs, <http://ace.orst.edu/info/extoxnet/>

ILC Glossary of internet terms, <http://www.matisse.net/files/glossary.html>

*Occupational Health Review*, feature discussing health and safety on the web in more detail, <http://www.irseclipse.co.uk/publications/osh-it.html>

University of Edinburgh, occupational health journal contents lists, <http://www.med.ed.ac.uk/hew/links/journals.html>

Department of the Environment, Transport and the Regions, sustainable production and use of chemicals: consultation paper on chemicals in the environment, <http://www.environment.detr.gov.uk/sustainable/chemicals/consult/index.html>

UNEP Prior Informed Consent, <http://irptc.unep.ch/pic/>, <http://www.chem.unep.ch/pic/>, <http://www.fao.org/pic/>

UNEP Chemicals/WHO, GEENET Project, <http://irptc.unep.ch/>

UNEP internet guide to finding information on chemicals, <http://irptc.unep.ch/irptc/iguide/table.html>

Pesticides Trust, <http://www.gn.apc.org/pesticidetrust/>

PANNA, <http://www.panna.org/panna/>

## **General Information on hazards and health and safety**

*Daily Hazard*, Newsletter of the London Hazards Centre (four issues per year).

*HAZLIT* is the London Hazards Centre library database. For more information about on-line access, contact the London Hazards Centre. *HAZTEXT* is the London Hazards Centre full text database. Both are on the web at [www.lhc.org.uk](http://www.lhc.org.uk)

*Hazards* (four issues per year), PO Box 199, Sheffield S1 1FQ.

*Labour Research and Bargaining Report*, monthly magazines from Labour Research Department, 78 Blackfriars Road, London SE1 8HF

Workers' Health International Newsletter, c/o Hazards, PO Box 199, Sheffield S1 1FQ

HSE free leaflets and priced publications can be ordered from:

HSE Books, PO Box 1999, Sudbury, Suffolk CO10 6FS;

Tel: 01787 881165

## **London Hazards Centre publications**

*The RSI Hazards Handbook: a workers' guide to Repetitive Strain Injuries and how to prevent them*, £12 (£4.50 to trade unions and community groups)

*Asbestos Hazards Handbook: a guide to safety at work, in the community and at home*, £12.00 (£5.00 to trade unions and community groups)

*Hard Labour: Stress, ill-health and hazardous employment practices*, £6.95

*VDU work and the hazards to health*, £6.50

*Protecting the Community: A worker's guide to health and safety in Europe*, £9.95

*Basic Health and Safety: Workers' rights and how to win them*, £6.00

*Sick Building Syndrome: Causes, effects and control*, £4.50

*Toxic Treatments: Wood preservative hazards at work and in the home*, £5.95

*Fluorescent Lighting: A health hazard overhead*, £5.00 (£2.00 to trade unions and community groups)

The London Hazards Centre also publishes a series of factsheets on hazards issues.

All are published on the website.

# INDEX

- AEEU 20
- ACTS 58-60
- allergens 18-19, 31-36, 79
- asbestos 4, 30, 62, 93
- asthma 2, 10-13, 16-18, 32, 74-76, 89
- BECTU 89
- Bhopal 1
- biological monitoring 14, 26, 80
- blood 15, 25-26
- body mapping 45, 88
- Bradshaw, Tony 20-22
- brain – *see* nervous system
- cancer 15-16, 19, 24, 26, 29-31, 39-41, 51, 60-61, 82, 88-89
- cardiovascular system 26
- Chapman, Enfys 64-67
- CHIP 99 38, 54, 63-64
- chloracne 19
- COMAH 68
- compensation 11, 20, 33, 48, 74-75
- confined spaces 55
- COSHH 17, 22, 34-35, 47-57, 71-76, 80, 87-89
- darkroom disease 74-76
- dermatitis 2, 18-19, 44, 88
- enforcement 85-86, 96
- epidemiology (*see also* workers' epidemiology) 42-43
- environment 90
- Europe 36, 60, 69, 93
- explosion 36
- exposure monitoring 51-52, 88
- Farrell, Peter 81-83
- fire 36
- first aid 80-81
- Flixborough 1
- GPMU 44, 57, 64
- Harris, Brian 33-35
- Hazards Campaign Charter 92-93
- Health and Safety Executive 2, 22, 25, 29, 36, 40, 54, 56-60, 64, 67, 72, 80, 85, 92
- health surveillance 12, 52, 80, 88
- Huber and Suhner 10-12
- Hutchins, Violette 10-13
- immune system 15, 31-36
- information 52-53
- just transition 73
- kidneys 15, 24-25
- labelling 63, 92
- lead 23, 26, 62-63
- liver 15, 23-24, 72
- local exhaust ventilation (*see* ventilation)
- lungs (*see* respiratory system)
- Maximum Exposure Limit 24, 47, 53, 58
- MDF 89
- Ministry of Defence 20-22
- monitoring (*see* exposure monitoring or biological monitoring)
- multiple chemical sensitivity 32-36
- mutagens 41-42
- MSF 33

nervous system 15, 19, 22, 82

occupational exposure limits  
(*see also* OES and MEL) 37, 56-62

Occupational Exposure Standard  
58

Ogden, David 74-76

organophosphates (*see* pesticides)

paint 81-83

permit to work 80

personal protective equipment  
49, 51, 71, 76-79, 87-88

Pesticide Exposure Group  
of Sufferers (PEGS) 64-67, 91

pesticides 2, 23, 35, 48-50, 64-67,  
80, 88-90, 94-95

Pesticides Trust 88, 90-92

poisoning

acute v chronic 15

routes of exposure

metabolism 14

Preece, Ryan 54-56

printing 71-72

Prior Informed Consent 93-94

radiation 36

reproductive hazards 15, 26-29

respiratory system 15-16

safety data sheets 29, 37, 54, 57,  
63-64, 87

safety representatives 50, 53, 81,  
84-85, 87-88

sheep dip (*see* pesticides)

Shepherd, Robert 48-50

Siemens Plessey 33-35

Simpson, Robert 54-56

skin disease (*see* dermatitis)

Society of Radiographers 74-76

solvents 13, 19-23, 26, 35, 71-72,  
81-83, 87-88

storage 79

SUBSPRINT 71-72

substitution 51, 71-72, 81-83, 87,  
91

SWORD 17

teratogen (*see* reproductive hazards)

TGWU 11, 85, 89-90

toxicity testing 27, 36-42

toxicology 8-9, 14

toxics use reduction 37, 68-69

training 52-53, 55, 78-79, 87

TUC 17-18, 81, 87-88

UCATT 83-85, 89

UNISON 48, 88

ventilation 73-74

WATCH 58-60

workers' epidemiology 44-45