Hazardous Chemical Substances Regulations

published under GN.1179 of 25 August 1995

amended by R.683 of 27 June 2008

The Minister of Labour has under section 43 of the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993), after consultation with the Advisory Council for Occupational Health and Safety, made the regulations in the Schedule.

SCHEDULE

1. Definitions. In this Schedule a word or expression to which a meaning has been assigned in the Act shall bear the meaning so assigned to it and unless the context otherwise indicates-

"air monitoring" means the monitoring of the concentrations of airborne hazardous chemical substances;

"Asbestos Regulations" means the *Asbestos Regulations* published by Government Notice No. R. 773 of 10 April 1987 under section 43 (5) of the Act;

"assessment" means a programme to determine any risk from exposure to a hazardous chemical substance associated with any hazard thereof at the workplace in order to identify the steps needed to be taken to remove, reduce or control such hazard;

"BEI" or "**biological exposure index"** is a reference value intended as a guideline for the evaluation of potential health hazards as listed in Table 3 of Annexure 1 hereby as revised from time to time and listed in the *Government Gazette;*

"engineering control measures" means control measures that remove or reduce the exposure of persons at the workplace by means of engineering methods;

"exposed" means exposed to a hazardous chemical substance whilst at the workplace and "exposure" has a corresponding meaning;

"EH 42" means the Guidance Note *EH 42 of the Health and Safety Executive* of the United Kingdom: *Monitoring Strategies for Toxic Substances* 1989 HSE ISBN 0 11885412 7 as revised from time to time and published in the *Government Gazette;*

"Facilities Regulations" means the Facilities Regulations published by Government Notice No. R. 2362 of 5 October 1990 under section 43 (5) of the Act;

"General Administrative Regulations" means the *General Administrative Regulations* published by Government Notice No. R. 2206 of 5 October 1984 under section 43 (5) of the Act;

"HCS" or **"hazardous chemical substance"** means any toxic, harmful, corrosive, irritant or asphyxiant substance, or a mixture of such substances for which—

(*a*) an occupational exposure limit is prescribed; or

(*b*) an occupational exposure limit is not prescribed, but which creates a hazard to health;

"intake" includes inhalation, ingestion or absorption through the skin or mucous membranes;

"Lead Regulations" means the *Lead Regulations* published by Government Notice No. R. 586 of 22 March 1991 under section 43 (5) of the Act;

"measurement programme" means a programme according to the monitoring strategy as contemplated in EH 42;

"monitoring" means the planning, carrying out and recording of the results of a measurement programme;

"OEL" or **"occupational exposure limit"** means a limit value set by the Minister for a stress factor in the workplace as revised from time to time by notice in the *Government Gazette;*

"OEL-CL" or "**occupational exposure limit - control limit"** means the occupational exposure limit for a hazardous chemical substance as listed in Table 1 of Annexure 1 hereby and "control limit" has a corresponding meaning;

"OEL-RL" or **"occupational exposure limit - recommended limit"** means the occupational exposure limit for a hazardous chemical substance as listed in Table 2 of Annexure 1 hereby and "recommended limit" has a corresponding meaning;

"OESSM" means the *Occupational Exposure Sampling Strategy Manual,* published by the National Institute for Occupational Safety and Health (NIOSH), Publication No. 77-173 of 1977, United States of America: Department of Health, Education and Welfare;

"regional director" means the regional director as defined in regulation 1 of the *General Administrative Regulations*;

"respiratory protective equipment" means a device which is worn over at least the mouth and nose to prevent the inhalation of airborne hazardous chemical substances and which is of a type, or conforms to a standard approved by the Minister;

"respirator zone" means an area where the concentration of an airborne hazardous chemical substance exceeds the recommended limit for that substance;

"SABS 072" the Code of Practice for the Safe Handling of Pesticides, SABS 072, published by the South African Bureau of Standards (SABS);

"SABS 0228" the Code of Practice for the Identification and Classification of Dangerous Substances and Goods, SABS 0228, published by the South African Bureau of Standards (SABS);

"SABS 0229" the Code of Practice for Packaging of Dangerous Goods for Road and Rail Transportation in South Africa, SABS 0229, published by the South African Bureau of Standards (SABS);

2. Scope of application.

(1) Subject to the provisions of subregulation (2), these regulations shall apply to an employer or a self-employed person who carries out work at a workplace which may expose any person to the intake of an HCS at that workplace.

(2) The provisions of regulations 3 (1), 6 and 7 shall not apply to—

(*a*) a self-employed person; or

(*b*) a person who visits a workplace as contemplated in subregulation (1).

(3) The provisions of these regulations shall not apply in the case where the Lead Regulations or Asbestos Regulations apply.

3. Information and training.

(1) An employer shall, before any employee is exposed or may be exposed, after consultation with the health and safety committee established for that section of the workplace, ensure that the employee is adequately and comprehensively informed and trained, as well as thereafter informed and trained at intervals as may be recommended by that health and safety committee, with regard to—

(*a*) the contents and scope of these regulations;

(*b*) the potential source of exposure;

(*c*) the potential risks to health caused by exposure;

(*d*) the potential detrimental effect of exposure on his or her reproductive ability;

(*e*) the measures to be taken by the employers to protect an employee against any risk from exposure;

(*f*) the precautions to be taken by an employee to protect himself or herself against the health risks associated with the exposure, including the wearing and use of protective clothing and respiratory protective equipment;

(*g*) the necessity, correct use, maintenance and potential of safety equipment, facilities and engineering control measures provided;

(*h*) the necessity of personal air sampling and medical surveillance;

(*i*) the importance of good housekeeping at the workplace and personal hygiene;

(*j*) the safe working procedures regarding the use, handling, storage and labelling of the HCS at the workplace; and

(*k*) procedures to be followed in the event of spillages, leakages or any similar emergency situation which could take place by accident.

(2) An employer or a self-employed person shall give written instructions of the procedures contemplated in paragraph (*k*) of subregulation (1) to the drivers of vehicles carrying the HCS.

(3) An employer or a self-employed person shall ensure that he himself or she herself or any person who in any manner assists him or her in the carrying out or the conducting of his or her business, have the necessary information and has undergone sufficient training in order for him or her to identify the potential risks and the precautions which should be taken.

4. Duties of persons who may be exposed to hazardous chemical substances.

A person who is or may be exposed, shall obey a lawful instruction given by or on behalf of the employer or a self-employed person, regarding—

(*a*) the prevention of an HCS from being released;

(*b*) the wearing of personal protective equipment;

(*c*) the wearing of monitoring equipment to measure personal exposure;

(*d*) the reporting for health evaluations and biological tests as required by these regulations;

(*e*) the cleaning up and disposal of materials containing HCS;

(*f*) housekeeping at the workplace, personal hygiene and environmental and health practices; and

(*g*) information and training as contemplated in regulation 3.

5. Assessment of potential exposure.

(1) An employer or self-employed person shall after consultation with the relevant health and safety representative or relevant health and safety committee, cause an immediate assessment to be made and thereafter at intervals not exceeding two years, to determine if any employee may be exposed by any route of intake.

(2) An employer shall inform the relevant health and safety representative or relevant health and safety committee in writing of the arrangements made for the assessment contemplated in subregulation (1), give them reasonable time to comment thereon and ensure that the results of the assessment are made available to the relevant representative or committee who may comment thereon.

(3) When making the assessment, the employer or self-employed person shall keep a record of the assessment and take into account such matters as—

(*a*) the HCS to which an employee may be exposed;

(*b*) what effects the HCS can have on an employee;

(*c*) where the HCS may be present and in what physical form it is likely to be;

(*d*) the route of intake by which and the extent to which an employee can be exposed; and

(*e*) the nature of the work, process and any reasonable deterioration in, or failure of, any control measures.

(4) If the assessment made in accordance with subregulation (3) indicates that any employee may be exposed, the employer shall ensure that monitoring is carried out in accordance with the provisions of regulations 6 and 7 and that the exposure shall be controlled as contemplated in regulation 10.

(5) An employer shall review the assessment required by subregulation (1) forthwith if—

(*a*) there is reason to suspect that the previous assessment is no longer valid; or

(*b*) there has been a change in a process involving an HCS or in the methods, equipment or procedures in the use, handling, control or processing of the HCS,

and the provisions of subregulations (2) and (3) shall apply.

6. Air monitoring.

(1) Where the inhalation of an HCS is concerned, an employer contemplated in regulation 5 (4) shall ensure that the measurement programme of the airborne concentrations of the HCS to which an employee is exposed, is—

(*a*) carried out in accordance with the provisions of these regulations;

(*b*) carried out only after the relevant health and safety representative or relevant health and safety committee has been informed thereof and given a reasonable opportunity to comment thereon;

(*c*) carried out by an approved inspection authority or by a person whose ability to do the measurements is verified by an approved inspection authority;

(*d*) representative of the exposure of employees to the airborne HCS in accordance with the provisions of subregulation (2); and

(*e*) verified in accordance with the provisions of subregulation (3) if the measurements are carried out by a person who is not an approved inspection authority.

(2) In order to comply with the provisions of subregulation (1) (*d*), an employer shall—

(*a*) ensure that the measurement programme, in the case of a group measurement, makes provision for the selection of the number of persons for a sample to be done as contemplated in chapters 3 and 4 and Technical Appendix A of the OESSM: Provided that such sample size shall be chosen for the top 10% of the group at the 95% confidence level for an HCS with a control limit and for the top 10% of the group at the 90% confidence level for an HCS with a recommended limit; and

(*b*) carry out representative measurements at least every 12 months for an HCS with a control limit and at least every 24 months for an HCS with a recommended limit: Provided that whenever the control limit or recommended limit which has been prescribed for an HCS is exceeded, the provisions of regulation 10 shall apply.

(3) In order to comply with the provisions of subregulation (1) (*e*), an employer shall obtain the service of an approved inspection authority who shall, at intervals not exceeding 24 months—

(*a*) verify, by examining the measurement and analysis equipment of the employer and questioning the person referred to in subregulation (1) (*c*) regarding the carrying out of the measurement programme;

(*b*) carry out the measurements prescribed by subregulations (1) and (2) for any one group; and

(*c*) enter the results of the investigation and measurements, as contemplated in paragraphs (*a*) and (*b*) respectively, in the record required by regulation 9.

7. Medical surveillance.

(1) An employer shall ensure that an employee is under medical surveillance if—

(*a*) the employee may be exposed to a substance listed in Table 3 of Annexure 1;

(*b*) the exposure of the employee to any substance hazardous to his or her health is such that an identifiable disease or adverse effect to his or her health may be related to the exposure, there is a reasonable likelihood that the disease or effect may occur under the particular conditions of his or her work and there are techniques to diagnose indications of the disease or the effect as far as is reasonably practicable; or

(*c*) the occupational health practitioner recommends that the relevant employee should be under medical surveillance in which case the employer may call on an occupational medicine practitioner to ratify the appropriateness of such recommendation .

(2) In order to comply with the provisions of subregulation (1), the employer shall, as far as is reasonably practicable, ensure—

(*a*) that an initial health evaluation is carried out by an occupational health practitioner immediately before or within 14 days after a person commences employment, where any exposure exists or may exist, which comprises—

(i) an evaluation of the employee's medical and occupational history;

(ii) a physical examination; and

(iii) any other essential examination which in the opinion of the occupational health practitioner is desirable in order to enable the practitioner to do a proper evaluation.

(*b*) that subsequent to the initial health evaluation contemplated in paragraph (*a*), the relevant employee undergoes examinations as contemplated in paragraph (*a*) (ii) and (iii), at intervals not exceeding two years, or at intervals specified by an occupational medicine practitioner.

(3) An employer shall not permit an employee who has been certified unfit for work by an occupational medicine practitioner to work in a workplace or part of a workplace in which he or she would be exposed: Provided that the relevant employee may be permitted to return to work which will expose him or her if he or she is certified fit for that work beforehand by an occupational medicine practitioner.

(4) The employer shall record and investigate the incident contemplated in subregulation (3) in compliance with regulation 8 of the General Administrative Regulations.

8. Respirator zone.

An employer shall ensure—

(*a*) that any workplace or part of a workplace under his or her control, where the concentration of an HCS in the air is, or may be, such that the exposure of employees working in that workplace exceeds the recommended limit without the wearing of respiratory protective equipment, is zoned as a respirator zone;

(*b*) that a respirator zone is clearly demarcated and identified by notice indicating that the relevant area is a respirator zone and that respiratory protective equipment as contemplated in regulation 11 must be worn there; and

(*c*) that no person enters or remains in a respirator zone unless he or she is wearing the required respiratory protective equipment.

9. Records.

An employer shall—

(*a*) keep records of the results of all assessments, air monitoring, and medical surveillance reports required by regulations 5, 6 and 7, respectively: Provided that personal medical records shall only be made available to an occupational health practitioner;

(*b*) subject to the provisions of paragraph (*c*), make the records contemplated in paragraph (*a*), excluding personal medical records, available for inspection by an inspector;

(*c*) allow any person subject to formal written consent of an employee, to peruse the records with respect to that particular employee;

(*d*) make the records of all assessments and air monitoring available for perusal by the relevant health and safety representative or relevant health and safety committee;

(*e*) keep all records of assessments and air monitoring for a minimum period of 30 years;

(*f*) keep all medical surveillance records for a minimum period of 30 years and if the employer ceases activities, all those records shall be handed over or forwarded by registered post to the relevant regional director; and

(*g*) keep a record of the investigations and tests carried out in terms of regulation 12 (*b*) and of any repairs resulting from these investigations and tests, and the records shall be kept for at least three years.

9A. Handling of hazardous chemical substances.

(1) Subject to section 10 (3) of the Act, every person who manufactures, imports, sells or supplies any hazardous chemical substance for use at work, shall, as far as is reasonably practicable, provide the person receiving such substance, free of charge, with a material safety data sheet in the form of Annexure 8, containing all the information as contemplated in either ISO 11014 or ANSIZ400.1.1993 with regard to—

(*a*) product and company identification;

(*b*) composition/information on ingredients;

(*c*) hazards identification;

(*d*) first-aid measures;

(*e*) fire-fighting measures;

(*f*) accidental release measures;

(*g*) handling and storage;

(*h*) exposure control/personal protection;

(*i*) physical and chemical properties;

(*j*) stability and reactivity;

(*k*) toxicological information;

(*l*) ecological information;

(*m*) disposal considerations;

(*n*) transport information;

(*o*) regulatory information; and

(*p*) other information:

Provided that, where it is not reasonably practicable to provide a material safety data sheet, the manufacturer, importer, seller or supplier shall supply the receiver of any hazardous chemical substance with sufficient information to enable the user to take the necessary measures as regards the protection of health and safety.

(2) Every employer who uses any hazardous chemical substance at work, shall be in possession of a copy of Annexure 8, or a copy of sufficient information, as contemplated in subregulation (1).

(3) Every employer shall make Annexure 8 or sufficient information, as contemplated in subregulation (1), available at the request of any interested or affected person.

10. Control of exposure to HCS.

(1) An employer shall ensure that the exposure of an employee is either prevented or, where this is not reasonably practicable, adequately controlled: Provided that—

(*a*) where there is exposure for which there is a recommended limit, the control of the exposure shall be regarded as adequate if the level of exposure is below that limit or if the relevant area is zoned and the level of exposure is reduced to below that recommended limit by means of adequate personal protective equipment only after the level has been reduced to as low as is reasonably practicable by any other means than personal protective equipment; or

(*b*) where there is exposure for which there is a control limit, the control of the exposure shall be regarded as adequate if the exposure is at a level as low as is reasonably practicable below that control limit: Provided that in the case of temporary excursions above the control limit, the employer shall ensure—

(i) that the excursion is without a significant risk from exposure;

(ii) that the excursion is not indicative of a failure to maintain adequate control;

(iii) that during the excursion, the area is temporarily demarcated as prescribed in regulation 8 (*b*); and

(iv) the provisions of regulation 11 are complied with.

(2) Where reasonably practicable, the employer shall control the exposure of an employee—

(*a*) by limiting the amount of an HCS used which may contaminate the working environment;

(*b*) by limiting the number of employees who will be exposed or may be exposed;

(*c*) by limiting the period during which an employee will be exposed or may be exposed;

(*d*) by using a substitute for an HCS;

(*e*) by introducing engineering control measures for the control of exposure, which may include the following:

(i) Process separation, automation or enclosure;

(ii) the installation of local extraction ventilation systems to processes, equipment and tools for the control of emissions of an airborne HCS;

(iii) use of wet methods; and

(iv) separate workplaces for different processes;

(*f*) by introducing appropriate work procedures which an employee must follow where materials are used or processes are carried out which could give rise to exposure of an employee and that procedures shall include written instructions to ensure—

(i) that an HCS is safely handled, used and disposed of;

(ii) that process machinery, installations, equipment, tools and local extraction and general ventilation systems are safely used and maintained;

(iii) that machinery and work areas are kept clean; and

(iv) that early corrective action can be readily identified .

(3) An employer shall ensure that the emission of an HCS into the atmosphere comply with the provisions of the Atmospheric Pollution Prevention Act, 1965 (Act No.45 of 1965).

11. Personal protective equipment and facilities.

(1) If it is not reasonably practicable to ensure that the exposure of an employee is adequately controlled as contemplated in regulation 10, the employer shall—

(*a*) in the case of an airborne HCS, provide the employee with suitable respiratory protective equipment and protective clothing; and

(*b*) in the case of an HCS which can be absorbed through the skin, provide the employee with suitable non-HCS impermeable protective equipment.

(2) Where respiratory protective equipment is provided, the employer shall ensure—

(*a*) that the relevant equipment is capable of controlling the exposure to below the OEL for the relevant HCS;

(*b*) that the relevant equipment is correctly selected and properly used;

(*c*) that information, instructions, training and supervision which is necessary with regard to the use of the equipment is known to the employees; and

(*d*) that the equipment is kept in good condition and efficient working order.

(3) An employer shall, as far as is reasonably practicable—

(*a*) issue no used personal protective equipment to an employee, unless the relevant protection equipment is decontaminated and sterilised;

(*b*) provide separate containers or storage facilities for personal protective equipment when not in use; and

(*c*) ensure that all personal protective equipment not in use is stored only in the place provided therefor.

(4) An employer shall as far as is reasonably practicable, ensure that all contaminated personal protective equipment is cleaned and handled in accordance with the following procedures:

(*a*) Where the equipment is cleaned on the premises of the employer, care shall be taken to prevent contamination during handling, transport and cleaning;

(*b*) where the equipment is sent off the premises to a contractor for cleaning purposes—

(i) the equipment shall be packed in impermeable containers;

(ii) the containers shall be tightly sealed and have clear indication thereon that the contents thereof are contaminated; and

(iii) the relevant contractor shall be fully informed of the requirements of these regulations and the precautions to be taken for the handling of the contaminated equipment.

(5) Subject to the provisions of subregulation (4) (*b*), an employer shall ensure that no person removes dirty or contaminated personal protective equipment from the premises: Provided that where contaminated personal protective equipment has to be disposed of, it shall be treated as HCS waste as contemplated in regulation 15.

(6) Subject to the provisions of the Facilities Regulations, an employer shall, where reasonably practicable, provide employees using personal protective equipment as contemplated in subregulation (1), with—

(*a*) adequate washing facilities which are readily accessible and located in an area where the facilities will not become contaminated, in order to enable the employees to meet a standard of personal hygiene consistent with the adequate control of exposure, and to avoid the spread of an HCS;

(*b*) two separate lockers separately labelled “protective clothing” and “personal clothing”, and ensure that the clothing is kept separately in the, locker concerned; and

(*c*) separate “clean” and “dirty” change rooms if the employer uses or processes an HCS to the extent that the HCS could endanger the health of persons outside the workplace.

12. Maintenance of control measures.

An employer shall ensure—

(*a*) that all control equipment and facilities provided in terms of regulations 10 and 11, are maintained in good working order; and

(*b*) that thorough examinations and tests of engineering control measures are carried out at intervals not exceeding 24 months by an approved inspection authority or by a person whose ability to do the measurements and tests is verified by an approved inspection authority.

13. Prohibitions.

No person shall as far as is reasonably practicable—

(*a*) use compressed air or permit the use of compressed air to remove particles of an HCS from any surface or person; or

(*b*) smoke, eat, drink or keep food or beverages in a respirator zone or permit any other person to smoke, eat, drink or keep food or beverages in that zone.

14. Labelling, packaging, transportation and storage.

An employer shall, in order to avoid the spread of contamination of an HCS, take steps, as far as is reasonably practicable, to ensure—

(*a*) that the HCS in storage or distributed are properly identified, classified and handled in accordance with SABS 072 and SABS 0228;

(*b*) that a container or a vehicle in which an HCS is transported, is clearly identified, classified and packed in accordance with SABS 0228 and SABS 0229; and

(*c*) that any container into which an HCS is decanted, is clearly labelled with regard to the contents thereof.

15. Disposal of hazardous chemical substances.

An employer shall as far as is reasonably practicable—

(*a*) recycle all HCS waste;

(*b*) ensure that all collected HCS waste is placed into containers that will prevent the likelihood of exposure during handling;

(*c*) ensure that all vehicles, re-usable containers and covers which have been in contact with HCS waste are cleaned and decontaminated after use in such a way that the vehicles, containers or covers do not cause a hazard inside or outside the premises concerned;

(*d*) ensure that all HCS waste which can cause exposure, is disposed of only on sites specifically designated for this purpose in terms of the Environmental Conservation Act, 1989 (Act No. 73 of 1989), in such a manner that it does not cause a hazard inside or outside the site concerned;

(*e*) ensure that all employees occupied in the collection, transport and disposal of HCS waste, who may be exposed to that waste, are provided with suitable personal protective equipment; and

(*f*) ensure that if the services of a waste disposal contractor are used, a provision is incorporated into the contract stating that the contractor shall also comply with the provisions of these regulations.

16. Offences and penalties.

Any person who contravenes or fails to comply with any provision of regulation 3, 4, 5, 6, 7, 8, 9, 9A, 10, 11, 12, 13, 14 or 15 shall be guilty of an offence and liable on conviction to a fine or to imprisonment for a period not exceeding six months and, in the case of a continuous offence, to an additional fine of R200 for each day on which the offence continues or additional imprisonment of one day for each day on which the offence continues: Provided that the period of such additional imprisonment shall in no case exceed 90 days.

17. Short title.—These regulations shall be called the Regulations for Hazardous Chemical Substances,1995.

Annexure 1:
HCS GUIDELINES

OCCUPATIONAL HEALTH AND SAFETY ACT, 1993

HCS Guidelines

Prevention and control of exposure

1. Exposure of employees to substances hazardous to health should be prevented or, where this is not reasonably practicable, adequately controlled. This is a fundamental requirement of the Regulations for Hazardous Chemical Substances (HCS), 1995. Exposure can occur by inhalation, ingestion or absorption through the skin, but inhalation is usually the main route of entry into the body. Tables 1 and 2 of Annexure 1 list the occupational exposure limits which should be used in determining the adequacy of control of exposure by inhalation, as required by the HCS Regulations.

2. The advice in this document should be taken in the context of the requirements of the HCS Regulations, especially regulation 5 (Assessment of potential exposure), regulation 10 (Control of exposure), regulation 12 (Maintenance of control measures) and regulation 6 (Air monitoring). Substances hazardous to health are defined in regulation 1. There is separate legislation for lead and asbestos and these substances are not covered in detail in this document. This document also does not apply to exposure below ground in mines or exposure to micro-organisms.

3. Adequate control of exposure (when prevention is not reasonably practicable) should be achieved by one or more of a range of control measures described in regulation 10 of the HCS Regulations. Control by personal protective equipment should be applied only when other means are not reasonably practicable.

Medical surveillance

4. Medical surveillance of employees is often an important addition to the control measures in the workplace. Regulation 7 (1) of the HCS Regulations specifies where medical surveillance is appropriate for the protection of the health of employees.

4.1 Medical surveillance is defined in the Regulations to cover the *spectrum* of potential effects of an HCS on an employee, from absorption of the substances through to clinical disease. Medical surveillance may be grouped broadly into—

(*a*) biological monitoring, to measure the extent of absorption of an HCS by the employee.

(*b*) medical screening, to detect any adverse effects of an HCS on the employee.

4.2 ***Biological monitoring of exposure***

4.2.1 Objectives

Biological monitoring of exposure can be divided into two types of testing:

(*a*) Biological monitoring: Measures the biochemical concentrations of HCSs and/or their metabolites in biological samples of exposed individuals, e.g. blood lead for inorganic lead exposure, or urinary arsenic for inorganic arsenic exposure. The aim is to measure the degree of absorption into the body by measuring indicators in representative biological samples, typically urine or blood (usually not related to the target organ).

(*b*) Biological effect monitoring: Determines the intensity of biochemical or physiological change due to exposure, e.g. red cell cholinesterase for exposure to organosphosphate pesticides, or zinc protoporphyrin (ZPP) for exposure to inorganic lead.

4.2.2 Uses of biological monitoring

Biological monitoring tests are indices of an individual's exposure and they may be a useful tool for the occupational health and safety team. They give information on the overall level of exposure, regardless of whether an HCS has been absorbed by the respiratory, oral, or cutaneous route.

Cutaneous absorption can play a significant role in the case of some organic compounds. The amounts absorbed through the skin may be comparable to or even higher than those absorbed via the respiratory tract.

Where appropriate, environmental control measures may thus be supplemented, with biological monitoring. Knowledge of the real individual exposure permits targeted applications of preventive measures.

4.2.3 Important considerations in biological monitoring

(*a*) In choosing a test to meet the above objectives, it is important to have an understanding of the relationship between environmental exposure and the concentration of an HCS in biological samples. This includes an understanding of the principles of absorption, biotransformation, distribution and excretion of an HCS.

(*b*) In addition, there should be analytical methods available of sufficient sensitivity and specificity to detect concentrations of the substance in urine, blood or exhaled air in the range likely to be encountered in industry.

(*c*) The HCSs listed in Table 3 of Annexure 1 are those for which the above criteria have a reasonable change of being met.

4.2.4 Biological Exposure Indices (BEIs)

BEIs are reference values intended as guidelines for the evaluation of potential health hazards in the practice of industrial hygiene. A BEI represents in theory the level of an HCS or metabolite most likely to be observed in a specimen collected from a healthy worker who has been exposed to an HCS to the same extent as the worker with inhalation exposure to an OEL-TWA. BEIs do not represent a sharp distinction between hazardous and non-hazardous exposures. For example, owing to biological variability, it is possible that an individual's measurements can exceed the BEI without incurring an increased health risk. Conversely, there may be some susceptible individuals who may be harmed at effects below the BEI.

If measurements in specimens obtained from a worker on different occasions persistently exceed the BEI, or if the majority of measurements in specimens obtained from a group of workers at the same workplace exceed the BEI, the cause of the excessive values must be investigated and proper action be taken to reduce the exposure.

BEIs apply to eight-hour exposures, five days a week. However, BEIs for differing work schedules may be extrapolated on pharmacokinetic grounds. BEIs should not be applied either directly or through a conversion factor, in the determination of safe levels for non-occupational exposure to air and water pollutants, or food contaminants. The BEIs are not intended for use as a measure of adverse effects or for diagnosis of occupational illness.

4.3 ***Medical screening***

4.3.1 Objectives

(*a*) The principle of general medical screening is to detect a disease at an early subclinical or presymptomatic stage in order to take action to reverse these effects or to slow progression of the disease. The abnormalities sought, include pathophysiological or histopathological changes. Such tests are well established in general preventative medicine, e.g. PAP smears for cervical cancer, cholesterol screening, faecal occult blood for lower bowel cancer, etc.

(*b*) In medical surveillance in industry one is interested not only in detecting adverse effects in the individual, but also in the implication of the findings for the effectiveness of workplace control measures. Medical surveillance is thus directed not only at early adverse effects but also at established disease.

4.3.2 Types of examination

(*a*) The number of validated screening tests with regard to HCSs is smaller than in general preventive medicine, but is likely to grow in the future. Examples of subclinical tests include urinary cytology for bladder cancer among workers exposed to potential bladder carcinogens, or full blood counts for employees exposed to an HCS toxic for the bloodforming organs.

(*b*) Medical surveillance may include simple clinical examination, such as examination of the skin of employees exposed to contact irritants or allergens, or of the nasal septum of employees exposed to chromates.

(*c*) Chest X-rays for silicosis are an example of screening for irreversible (although potentially progressive) disease. Lung function testing is well established as a non-specific test for the possible effect of respiratory irritants, sensitisers and fibrogenic agents.

4.4 ***Designing and implementing a programme of medical surveillance***

4.4.1 The following steps should be included in any programme:

(*a*) *Risk assessment* to determine the potential exposure to and routes of absorption of any HCS, as required by regulation 5.

(*b*) *Identification of target-organ toxicity,* so as to direct medical screening.

(*c*) *Selection of appropriate tests and testing schedule.* Tests should have the desirable operating characteristics of high sensitivity, specificity, reliability and predictive value. The frequency of testing is laid down in general terms by regulation 7 (2), but should in any case be based on an understanding of the nature of the hazard and the natural history of any adverse effects.

(*d*) *Development of action criteria.* These are provided for some HCSs in the form of BEIs in Table 3 of Annexure 1. Criteria for interpreting lung function testing have also been published in the medical literature. However, in many cases, the occupational health practitioners will have to develop pragmatic criteria in the context of the specific workplace.

(*e*) *Standardisation of test process.* Quality control needs to be exercised both in the testing site and in the laboratory contracted to carry out analyses. Consistency over time should be sought so as to make longitudinal measurements comparable.

(*f*) *Ethical considerations.* Information and training of employees as required by regulation 3 (1) should include the rationale for doing medical surveillance, and the consequence of abnormal findings. An employee must be notified of the results and interpretation of his/her tests and any recommendations made. The confidentiality of personal medical records is laid down by regulation 9.

(*g*) *Determination of employee's fitness to remain in that job.* [Regulation 7 (3)]. Results may be compared against the action criteria (BEI if relevant), and preferably also the employee's previous results to determine whether individual action needs to be taken. Action may include repeating the test, further medical examination, removal of the employee from further exposure, and notification of the employer. Co-operation of employees can be best secured by a policy of protection of conditions of service in case of medical removal from a particular job.

(*h*) *Evaluation of control.* An abnormal finding in an employee, or a pattern of findings in a group of employees, may point to inadequate primary control of exposure. In such cases the employer needs to be notified of such details of the medical findings as are necessary to evaluate the workplace problem and take remedial action.

(*i*) *Recordkeeping.* This includes both medical records and exposure information for every employee. While the employer is responsible for recordkeeping in terms of regulation 9, the contents of personal medical records may be accessible to the occupational medicine practitioner, the employee, and any person nominated by the employee in writing.

4.4.2 The onus is on the occupational health practitioner carrying out medical surveillance to be familiar with the latest scientific information regarding the HCS and tests that might be useful. The aim should be to design a programme that is rational, ethical and effective. This may have to be done in the face of incomplete information or uncertainty regarding exposures, toxicity and test performance.

Legal background to exposure limits

5. Two types of occupational exposure limits are defined in regulation 1 of the HCS Regulations. The two types are *occupational exposure limit-control limit* (OEL-CL), and *occupational exposure-limit recommended* limit (OEL-RL), as listed in Tables 1 and 2 of Annexure 1. The key difference between the two types of limits is that one OEL-RL is set at a level at which there is no indication of a risk to health; for an OEL-CL, a residual risk may exist and the level set, takes socio-economic factors into account. Further details are given in paragraphs 8 to 16.

6. Regulation 10 of the HCS Regulations lays down the requirements for the use of an OEL-CL and an OEL-RL for HCS for the purpose of achieving adequate control. Regulation 10 (1) requires that, where there is exposure to a substance for which an OEL-CL is specified in Table 1 of Annexure 1, the control of exposure shall, so far as inhalation of that substance is concerned, be treated as adequate only if the level of exposure is reduced so far as is reasonably practicable and in any case below the OEL-CL.

7. Regulation 10 (1) of the HCS Regulations requires that, where there is exposure to a substance for which an OEL-RL has been approved, the control of exposure shall, so far as inhalation of that substance is concerned, be treated as adequate if—

(*a*) that OEL-RL is not exceeded; or

(*b*) where that OEL-RL is exceeded, the employer identifies the reasons for the exceeding of the standard and takes appropriate action to remedy the situation as soon as is reasonably practicable.

Setting occupational exposure limits

Advisory council and standing technical committee

8. OEL-RL and OEL-CL are set by the chief inspector on recommendation of the Advisory Council for Occupational Health and Safety (the Advisory Council), following assessment by the Standing Committee No. 7 (TC 7) of the Advisory Council for Occupational Health and Safety.

9. TC 7 must first consider what *type* of limit is appropriate, OEL-RL or OEL-CL, and secondly, at what *concentration* the limit should be set. Setting an OEL-RL is the first option to be considered and TC 7 comes to a decision based on a scientific judgment of the available information on health effects. If, however, TC 7 decides that an OEL-CL is more appropriate, consideration of the level at which to set the limit passes to the Advisory Council, since it involves socio-economic judgments, balancing risk to health against the cost and effort of reducing exposure.

Following public consultation, new OEL-CLs and OEL-RLs are listed in Table 1 and Table 2 of Annexure 1 respectively with the approval of the chief inspector.

The indicative criteria

10. An OEL-RL can be assigned to a substance, if all three the following criteria are complied with:

There is a no-risk at the exposure limit

Criterion 1: The available scientific evidence allows for the identification, with reasonable certainty, of a concentration averaged over a reference period, at which there is no indication that the substance is likely to be injurious to employees if they are exposed by inhalation day after day to that concentration.

Likely excursions above the exposure limit are unlikely

Criterion 2: Exposure to concentrations higher than that derived under criterion 1 and which could reasonably occur in practice, is unlikely to produce serious short or long-term effects on health over the period of time it might reasonably be expected to take to identify and remedy the cause of excessive exposure.

Compliance is reasonably practicable

Criterion 3: The available evidence indicates that compliance with an OEL-RL, as derived under criterion 1, is reasonably practicable.

11. A substance which does not meet criteria 1, 2 and 3, can be assigned an OEL-CL and must meet either of the following criteria:

Criterion 4: The available evidence on the substance does not satisfy criterion 1 and/or 2 for an OEL-RL and exposure to the substance has, or is liable to have, serious health implications for workers; or

Criterion 5: Socio-economic factors indicate that although the substance meets criteria 1 and 2 for an OEL-RL, a numerically higher value is necessary if the controls associated with certain uses are to be regarded as reasonably practicable.

Setting an OEL-RL

12. Criterion 1 sets out the fundamental basis for establishing such a limit: The existence of a threshold above which there may be evidence of significant effects on health but below which, on existing knowledge, there are thought to be no adverse effects.

13. Criterion 2 is necessary in order to take account of HCS Regulation 10 (1) of the HCS Regulations whereby exposures above an OEL-RL are allowed provided the employer identifies the reasons for exceeding the standard and takes steps to reduce exposure to that OEL-RL as soon as is reasonably practicable. Clearly, it is necessary to take account of the likelihood and probable extent of cases in deciding whether an OEL-RL is appropriate. The health effects to be taken into account include sensory and other effects such as the slowing of reflexes which might result in the impairment of safety.

14. Criterion 3 takes account of whether industry can reasonably comply with the exposure limit derived under the first criterion. There is no purpose in setting an OEL-RL which plainly cannot be achieved in practice. Note that industry's ability to comply, influences the decision of whether to set an OEL-RL, but does not influence the level at which that OEL-RL is set.

Setting an OEL-CL

15. To be assigned an OEL-RL, a substance must meet all the first three criteria; if it does not, then it can be considered for an OEL-CL. To be assigned an OEL-CL, there should be serious implications for the health of workers exposed to the substance. Serious health implications include both the risk of serious health effects to a small population of workers and the risk of relatively minor health effects to a large population. In practice, an OEL-CL has been most often allocated to carcinogens and to other substances for which no threshold of effect can be identified and about which there is no doubt about the seriousness of the effects of exposure.

16. An OEL-CL and an OEL-RL, therefore, differ not only in their legal status, but also in the way in which they are set. For an OEL-RL the only consideration in setting the limits is the protection of the health of the employee; for an OEL-CL this is still the primary consideration but socio-economic factors are also taken into account.

17. The indicative criteria, then, provide the framework within which the discussions at the various stages of limit-setting can be conducted.

Applying occupational exposure limits

General

18. The lists of occupational exposure limits given in Tables 1 and 2 of Annexure 1, unless otherwise stated, relate to personal exposure to substances hazardous to health in the air of the workplace.

Units of measurement

19. In occupational exposure limits, concentrations of gases and vapours in air are usually expressed in parts per million (ppm), a measure of concentration by volume, as well as in milligrams per cubic metre of air (mg m^{-3}), a measure of concentration by mass. In converting from ppm to mg m^{-3} a temperature of 25°C and an atmospheric pressure of 101,325 kPa are used. Concentrations of airborne particles (fume, dust, etc) are usually expressed in mg m^{-3}. In the case of dust, the limits in the tables refer to the *total inhalable* fraction unless specifically indicated as referring to the *respirable* fraction (see paragraph 36). In the case of a man-made mineral fibre, the limit is expressed as fibres per millilitre of air (fibres $m\ell^{-1}$).

Occupational exposure limits – control limits: OEL-CL (table 1)

20. An OEL-CL is the maximum concentration of an airborne substance, averaged over a reference period, to which employees may be exposed by inhalation under any circumstances, and is specified together with the appropriate reference period in Table 1 of Annexure 1.

21. Regulation 19 (1) of the HCS Regulations, when read in conjunction with the Act, imposes a duty on the employer to take all reasonable precautions and to exercise all due diligence to ensure that exposure is kept as far below an OEL-CL as is reasonably practicable.

22. To comply with this duty, in the case of substances with an 8-hour reference period, employers should undertake a programme of monitoring in accordance with regulation 6 so that they can show (if it is the case), that an OEL-CL is not exceeded. Such a monitoring programme need not be undertaken if the assessment carried out in accordance with regulation 5 shows that the level of exposure is most unlikely ever to exceed an OEL-CL. For substances assigned a short-term limit, such value should never be exceeded.

23. The assessment should also be used to determine the extent to which it is reasonably practicable to reduce exposure further below an OEL-CL as required by regulation 10 (1). In assessing reasonable practicability, the nature of the risk presented by the substance in question should be weighed against the cost and the effort involved in taking measures to reduce the risk. (Also see the definition of “reasonably practicable” as defined in the Act.)

Occupational exposure limit – recommended limit: OEL-RL (table 2)

24. An OEL-RL is the concentration of an airborne substance, averaged over a reference period, at which, according to current knowledge, there is no evidence that it is likely to be injurious to employees if they are exposed by inhalation, day after day, to that concentration.

25. For a substance which has been assigned an OEL-RL, exposure by inhalation should be reduced to that standard. However, if exposure by inhalation exceeds the OEL-RL, then control will still be deemed to be adequate provided that the employer has identified why the OEL-RL has been exceeded and is taking appropriate steps to comply with the OEL-RL as soon as reasonably practicable. In such a case, the employer's objective must be to reduce exposure to the OEL-RL, but the final achievement of this objective may take some time. The assessment under regulation 5 will determine the urgency of the necessary action, taking into account the extent and cost of the required measures in relation to the nature and degree of exposure involved.

26. Control of an OEL-RL as prescribed in regulation 10 (1) (*a*) can always be regarded as adequate control of that substance for the purposes of the HCS Regulations, so far as exposure from inhalation is concerned. However, due to the variations in process control and the fluctuations in substance concentrations in the workplace, it will be prudent for employers to reduce exposure below an OEL-RL so as to ensure that the exposure of all employees does not exceed that OEL-RL. Similarly, it is not intended that the statutory requirements under regulation 10 (1) should discourage the further application of good occupational hygiene principles in order to reduce exposure below the OEL-RL.

Long-term and short-term exposure limits

27. The pattern of effects due to exposure to substances hazardous to health varies considerably depending on the nature of the substance and the exposure. Some effects require prolonged or accumulated exposure. The long-term (8-hour time weighted average) exposure limit is intended to control such effects by restricting the total intake by inhalation over one or more workshifts. Other effects may be seen after brief exposures which have occurred once or repeatedly. Short-term limits (usually 15 minute) may be applied to such substances. Where long-term limits also apply, the short-term limits restrict the magnitude of excursion above the average concentration during longer exposures. For those substances for which no short-term limit is specified, it is recommended that a figure of three times the long-term limit be used as a guideline for controlling short-term excursions in exposure. With some other substances, brief exposure may be critical and the exposure limit necessary to prevent these excursions will also control any other effects. A separate long-term limit is not considered necessary in such cases and the short-term limit applies throughout the shift.

28. Exposure limits are expressed as airborne concentrations averaged over a specified period of time. The period for the long-term limit is normally eight hours. When a different period is used, this

is stated. The averaging period for the short-term exposure limit is normally 15 minutes. Such a limit applies to any 15 minute period throughout the working shift.

Limitations to the application of exposure limits

29. The exposure limits relate to personal exposure with the exception of the annual OEL-CL for vinyl chloride which should be recorded as the timeweighted average of vinyl chloride in the atmosphere of a working place over a period of one year (see Annexure 2) and the OEL-RL for cotton dust is not a personal exposure standard, but a static air standard (see Annexure 4).

30. The limits cannot readily be extrapolated to evaluate or control non-occupational exposure, e.g. levels of contamination in the neighbourhood close to an industrial plant. OELs only apply to persons at work. Employers should also take into account their duties under the Environmental Protection Act. The OELs are also only approved for use where the atmospheric pressure is between 85 KPa and 101,325 KPa. This covers the normal range of meteorological variations and slightly pressurised workplaces such as cleaning rooms, but not the higher pressures that may be encountered in, for example, tunnelling or underwater hyperbaric chambers. Such situations require special assessments.

31. Occupational exposure limits, as set out in Tables 1 and 2 of Annexure 1, are intended to be used for normal working conditions in workplaces. Employers should also take into account their duties and the provisions of the Environmental Conservation Act. OELs are not, however, designed to deal with serious accidents or emergencies, particularly where employees may be exposed to rapidly rising concentrations of gas, as may arise from a major escape due to plant failure. Over and above their responsibilities to ensure that the requirements of the HCS Regulations are met, employers also have a clear responsibility to ensure that the plant is designed, operated and maintained in a way that avoids accidents and emergencies. Where appropriate, detection, alarm and response measures should be used in order to minimise the effect of any such unplanned events.

32. To help maintain adequate operational control, employers may find it helpful to select their own indicators of control when undertaking investigations or corrective action.

Exposure in mines

33. The HCS Regulations and the occupational exposure limits in this publication do not apply to exposure to substances hazardous to health in mines.

Lead and asbestos

34. Work with asbestos or lead is not subject to the HCS Regulations. The exposure limits for various types of asbestos and lead are specified in the Asbestos Regulations and the Lead Regulations.

Pesticides

35. Substances used as active ingredients in pesticides are listed under their chemical names and/or their common (ISO) names. These names may sometimes be used as parts of the names of proprietary pesticide formulations. In all cases the exposure limit applies to the specific active ingredients and not to the formulation as a whole.

Dusts

36. The general approach necessary to control occupational exposure to dusts is as follows: not all dusts have been assigned occupational exposure limits but the lack of such limits should not be taken to imply an absence of hazard. In the absence of a specific exposure limit for a particular dust, exposure should be adequately controlled. Where there is no indication of the need for a lower value, personal exposure should be kept below both 10 mg m^{-3} 8-hour time-weighted average total inhalable dust and 5 mg m^{-3} timeweighted average respirable dust. Such, or greater, dust concentrations should be taken as the *substantial concentrations.* A *substantial* concentration of dust should be taken as a concentration of 10 mg m^{-3}, 8-hour time-weighted average, of total inhalable dust or 5 mg m^{-3}, 8-hour time-weighted average, of respirable dust, where there is no indication of the need for a lower value, and as such they are referred to as *substances hazardous to health.*

Total inhalable dust and respirable dust

37. *Total inhalable dust* approximates to the fraction of airborne material that enters the nose and mouth during breathing and is therefore available for deposition in the respiratory tract. *Respirable dust* approximates to the fraction which penetrates to the gas exchange region of the lung. A fuller definition is given at the end of Table 2 of Annexure 1 (Abbreviations).

38. Where dusts contain components which have their own assigned occupational exposure limits, all the relevant limits should be complied with.

Fume

39. Where a separate OEL has been set for *fume,* it should normally be applied to solid particles generated by chemical reactions or condensed from the gaseous state, usually after volatilisation from melted substances. The generation of fume is often accompanied by a chemical reaction such as oxidation or thermal breakdown.

Absorption through the skin

40. In general, for most substances the main route of entry into the body is by inhalation. The OELs given in these regulations solely relate to exposure by this route. Certain substances such as phenol, aniline and certain pesticides (marked in the Tables with an *SK* notation) have the ability to penetrate the intact skin and thus become absorbed into the body. Absorption through the skin can result from localised contamination, for example from a splash on the skin or clothing, or in certain cases from exposure to high atmospheric concentrations of vapour. Serious effects can result in little or no warning and it is necessary to take special precautions to prevent skin contact when handling these substances. Where the properties of the substances and the methods of use provide a potential exposure route via skin absorption, these factors should be taken into account in determining the adeauacv of the control measures.

Sensitisers

41. Certain substances may cause sensitisation of the respiratory tract if inhaled or skin contact occurs. Respiratory sensitisers can cause asthma, rhinitis, or extrinsic allergic alveolitis. Skin sensitisers cause allergic contact dermatitis. Substances which cause skin sensitations are not necessarily respiratory sensitisers or vice-versa. Only a proportion of the exposed population will become sensitised, and those who do become sensitised, will not have been identified in advance. Individuals who become sensitised may produce symptoms of ill health after exposure even to minute concentrations of the sensitiser.

42. Where it is reasonably practicable, exposure to sensitisers should be prevented. Where this cannot be achieved, exposure should be kept as low as is reasonably practicable and activities giving rise to short-term peak-concentrations should receive particular attention. As with other substances, the spread of contamination by sensitisers to other working areas should also be prevented, as far as is reasonably practicable.

43. The *Sen* notation (marked in the Tables with a *Sen* notation) has been assigned only to those sensitisers that may cause sensitisation by inhalation. Remember that other substances not contained in these Tables can act as respiratory sensitisers.

Other factors

44. Working conditions which impose additional stress on the body, such as exposure to ultra-violet radiation, high temperatures, pressures and humidity, may increase the toxic response to a substance. In such cases, specialist advice may be necessary to evaluate the effects of these factors.

Mixed exposures

General

45. The majority of OELs listed in Tables 1 and 2 of Annexure 1 are for single compounds or for substances containing a common element or radical, e.g. *tungsten and compounds, and isocyanates.* A few of the limits relate to substances commonly encountered as complex mixtures or compounds e.g. *white spirit, rubber fume,* and *welding fume.* However, workers are frequently subject to other mixed exposures involving solids, liquids, aerosols or gases. These exposures can arise as a result of work with materials containing a mixture of substances, or from work with several individual

substances, simultaneously or successively, in a workshift. Mixed exposures require careful assessment of their health effects and the appropriateness of control standards. The following paragraphs provide a brief summary of the advice on the application of exposure limits in these circumstances. In all cases of doubt, specialist advice should be sought.

Effects of mixed exposures

46. The ways in which the constituent substances of a mixed exposure interact, vary considerably. Some mixed exposures involve substances that act on different body tissues or organs, or by different toxicological mechanisms, these various effects being independent of each other. Other mixtures will include substances that act on the same organs, or by similar mechanisms, so that the effects reinforce each other and the substances are additive in their effect. In some cases the overall effect is considerably greater than the sum of the individual effects and the system is synergistic. This may arise from mutual enhancement of the effects of the constituents or because one substance potentiates another, causing it to act in a way which it would not do alone.

Assessment and control

47. With all types of mixed exposures, it is essential that assessments be based on the concentrations of each of the constituents in air to which workers are exposed. Depending on the nature of the consituents and the circumstances of use, the relative concentrations of the constituents in air may differ considerably from those in the liquid or solid source material. The composition of the bulk material should not be relied on for assessment unless there is good evidence for doing so.

48. Where mixed exposure occur, the first step is to ensure adequate control of exposure for each individual substance. However, the nature and amount of the other substances in a mixture can influence the level to which it is reasonable practicable to reduce exposure to a substance subject to an OEL-CL. When limits for specific mixtures have been established, they should be used only where they are applicable, and in addition to any relevant individual limits. They should not be extended to inappropriate situations. It is then necessary to assess whether further control is needed to counteract any increased risk from the substances acting in conjunction. Expert assessments for some particular mixed exposures may be available and can be used as guidelines in similar cases. In other cases, close examination of the toxicological data will be necessary to determine which of the main types of interaction (if any) are likely for the particular combination of substances concerned. The various types should be considered in the following order:

(*a*) **Synergistic substances:** Known cases of synergism and potentiation are considerably less common than the other types of behaviour in mixed exposures. However, they are the most serious in their effects and require the most strict control. They are also the most difficult to assess and wherever there is reason to suspect such interaction, specialist advice should be obtained;

(*b*) **Additive substances:** Where there is reason to believe that the effects of the constituents are additive, and where the exposure limits are based on the same health effects, the mixed exposure should be assessed by means of the formula—

$$C_1/L_1+C_2/L_2+C_3/L_3 \ldots\ldots < 1$$

here C_1, C_2, etc are the time-weighted average (TWA) concentrations of constituents in air and L_1, L_2, etc are the corresponding exposure limits. The use of this formula is only applicable where the additive substances have been assigned OELs, and L_1, L_2, etc. relate to the same reference period in the list of approved OELs. Where the sum of the C/L fractions does not exceed one, the exposure is considered not to exceed the national OELs. If one of the constituents has been assigned an OEL-CL, then the additive effect should be taken into account in deciding the extent to which it is reasonably practicable to further reduce exposure; and

(*c*) **Independent substances:** Where no synergistic or additive effects are known or considered likely, the constituents can be regarded as acting independently. It is then sufficient to ensure compliance with each of the OELs individually.

49. The above steps provide basic protocol for assessment of mixed exposures. It is open to persons responsible for control of exposure to treat all nonsynergistic systems as though they were

additive. This avoids the need to distinguish additive and independent systems and can be regarded as the more prudent course, particularly where the toxicity data are scarce or difficult to assess.

Monitoring mixed exposure

50. Further information on monitoring airborne contaminants is given in paragraphs 52 and 53. The number of components of a mixed exposure for which routine air monitoring is required, can be reduced if their relative concentrations can be shown to be constant. This involves the selection of a key or marker, which may be one of the constituents, as a measure of the total contamination. Exposure to the marker is controlled at a level selected so that exposures to all components will be controlled in accordance with the criteria in paragraphs 48 (*a*) and (*b*). However, if one of the components has been assigned an OEL-CL, the level of the exposure to that substance should always be reduced as far as is reasonably practicable. If this approach is to be used, it should take place under the guidance of suitable specialist advice.

Complicating factors

51. Several factors that complicate the assessment and control of exposure to individual substances will also affect cases of mixed exposures and will require similar special consideration. Such factors include-

(*a*) exposure to a substance for which there is no established limit or for which an OEL-CL has been set;

(*b*) the relevance of factors such as alcohol, medication, smoking and additional stresses;

(*c*) exposure of the skin to one or more substances that can be absorbed by this route, as well as by inhalation; and

(*d*) substances in mixture may mutually affect the extent of their absorption, as well as their health effects, at a given level of exposure.

Monitoring exposure

52. Regulation 5 (4) of the HCS Regulations imposes a duty on the employer to monitor the exposure of employees to substances hazardous to health.

53. Details of routine sampling strategies for individual substances are outside the scope of this document. However, advice is available in EH 42, which provides practical guidance on monitoring substances hazardous to health in air.

TABLE 1

OCCUPATIONAL EXPOSURE LIMITS – CONTROL LIMITS FOR HAZARDOUS CHEMICAL SUBSTANCES

Substance	Formula	TWA OEL-CL		SHORT TERM OEL-CL		1995
		ppm	mg/m^3	ppm	mg/m^3	Notes
Acrylamide	$CH_2=CHCONH_2$	-	0.3	-	-	Sk
Acrylonitrile	$CH_2=CHCN$	2	4	-	-	Sk
Arsenic & compounds, except arsine (as As)	As	-	0.1	-	-	
Asbestos	See Asbestos Regulations					
Benzene	C_6H_6	5	16	-	-	
Bis (chloromethyl) ether (BCME)	$ClCH_2OCH_2Cl$	0.001	0.005		-	New
Buta-1,3-diene	$CH_2=CHCH=CH_2$	10	22	-	-	
2-Butoxyethanol	$C_4H_9OCH_2CH_2OH$	25	120	-	-	Sk
Cadmium & cadmium compounds, except cadmium oxide fume and cadmium sulphide pigments (as Cd)	Cd	-	0.05	-	-	
Cadmium oxide fume (as Cd)	CdO	-	0.05	-	0.05	
Cadmium sulphide pigments (respirable dust Cd)	CdS	-	0.04	-	-	

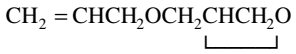
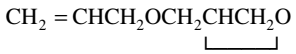
Carbon disulphide	CS_2	10	30	-	-	Sk
Chromium (VI) compounds (as Cr)	Cr		0.05	-	-	
1,2-Dibromoethane (ethylene dibromide)	$BrCH_2CH_2Br$	0.5	4	-	-	Sk
Dichloromethane	CH_2Cl_2	100	350	-	-	
2,2'-Dichloro-4,4' methylene dianiline (MbOCA)	$CH_2.(C_6H_3ClNH_2)_2$	-	0.005	-	-	Sk
2-Ethoxyethanol	$C_2H_5OCH_2CH_2OH$	10	37	-	-	Sk
2-Ethoxyethyl acetate	$C_2H_5OCH_2CH_2OOCCH_3$	10	54	-	-	Sk
Ethylene oxide	CH_2CH_2O	5	10	-	-	
Formaldehyde	HCHO	2	2.5	2	2.5	
Grain dust	See Annexure 7	-	10	-	-	Sen
Hydrogen cyanide	HCN	-	-	10	10	Sk
Isocyanates, all (as-NCO)		-	0.02	-	0.07	Sen
Lead and compounds	See Lead Regulations					
2-Methoxyethanol	$CH_3OCH_2CH_2OH$	5	16	-	-	Sk
2-Methoxyethyl acetate	$CH_3COOCH_2CH_2OCH_3$	5	24	-	-	Sk
Nickel	Ni	-	0.5	-	-	
Nickel, inorganic compounds (as Ni)	Ni					
soluble compounds		-	0.1	-	-	
insoluble compounds		-	0.5	-	-	
Rubber process dust	See Annexure 6	-	8	-	-	
Rubber fume		-	0.6	-	-	
Silica, crystalline	SiO_2					
respirable dust		-	0.1	-	-	
Styrene	$C_6H_5CH=CH_2$	100	420	250	1050	
1,1,1-Trichloroethane	CH_3CCl_3	350	1900	450	2450	
Trichloroethylene	$CCl_2=CHCl$	100	535	150	802	Sk
**Vinyl chloride	$CH_2=CHCl$	7	-	-	-	
Vinylidene chloride	$CH_2=CCl_2$	10	40	-	-	
Wood dust (hard wood)		-	5	-	-	Sen

**Vinyl chloride is also subject to an overriding annual TWA OEL-CL of 3 ppm.

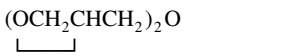
TABLE 2

OEL-RL: OCCUPATIONAL EXPOSURE LIMIT – RECOMMENDED LIMIT FOR HAZARDOUS CHEMICAL SUBSTANCES

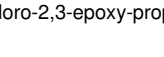
Substance	Formula	TWA OEL-RL		SHORT TERM		1995
		ppm	mg/m^3	ppm	mg/m^3	Notes
Acetaldehyde	$CH_3=CHO$	100	180	150	270	
Acetic acid	CH_3COOH	10	25	15	37	
Acetic anhydride	$(CH_3CO)_2O$	-	-	5	20	
Acetone	CH_3COCH_3	750	1780	1500	3560	
Acetonitrile	CH_3CN	40	70	60	105	
o-Acetylsalicylic acid	$CH_3COOC_6H_4COOH$	-	5	-	-	
Acrylaldehyde (Acrolein)	$CH_2=CHCHO$	0.1	0.25	0.3	0.8	
Acrylic acid	$CH_2=CHCOOH$	10	30	20	60	
Aldrin (ISO)	$C_{12}H_8Cl_6$	-	0.25	-	0.75	Sk
Allyl alcohol	$CH_2=CHCH_2OH$	2	5	4	10	Sk

Allyl chloride	CH_2=$CHCH_2Cl$	1	3	2	6	
Allyl 2,3-epoxypropyl ether		5	22	10	44	Sk
Allyl glycidyl ether (AGE)		5	22	10	44	Sk
Aluminium alkyl compounds		-	2	-	-	
* Aluminium metal	A1					
total inhalable dust		-	10	-	-	
respirable dust		-	5	-	-	
* Aluminium oxides	Al_2O_3,$Al(OH)_3$ and AlOOH					
total inhalable dust		-	10	-	-	
respirable dust		-	5	-	-	
Aluminium salts, soluble		-	2	-	-	
Aminodimethyl-benzene	$(CH_3)_2C_6H_3NH_2$	2	10	10	50	Sk

* The OEL-RL for aluminium does not include exposure to aluminium coated with mineral oil, or to fume arising from aluminium welding processes.

Substance	Formula	TWA OEL-RL		SHORT TERM OEL-RL		1995
		ppm	mg/m^3	ppm	mg/m^3	Notes
2-Aminoethanol	$NH_2CH_2CH_2OH$	3	8	6	15	
2-Aminopyridine	$NH_2C_5H_4N$	0.5	2	2	8	
Ammonia	NH_3	25	17	35	24	
Ammonium chloride, fume	NH_4Cl	-	10	-	20	
Ammonium sulphamidate	$NH_2SO_3NH_4$	-	10	-	20	
n-Amyl acetate	$CH_3COOC_5H_{11}$	100	530	150	800	
sec-Amyl acetate	$CH_3COOCH(CH_3)C_3H_7$	-	-	150	800	
Aniline	$C_6H_5NH_2$	2	10	5	20	Sk
Anisidines, *o*- and *p*-isomers	$NH_2C_6H_4OCH_3$	0.1	0.5	-	-	Sk
Antimony & compounds (as Sb)	Sb	-	0.5	-	-	
Arsine	AsH_3	0.05	0.2	-	-	
Asphalt, petroleum fumes		-	5	-	10	
Aspirin	$CH_3COOC_6H_4COOH$	-	5	-	-	
Atrazine (ISO)	$C_8HI_4ClN_5$	-	10	-	-	
Azinphos-methyl (ISO)	$(CH_3O)_2PSSCH_2.(C_7H_4N_3O)$	-	0.2	0.6	-	Sk
Aziridine		-	10	-	-	
y-BHC (ISO)	$C_6H_5Cl_6$	-	0.5	-	1.5	Sk
Barium compounds, soluble (as Ba)	Ba	-	0.5	-	-	
Barium sulphate, respirable dust	$BaSO_4$	-	2	-	-	
Benomyl (ISO)	$C_{14}H_{18}N_4O_3$	-	10	-	15	
Benzenethiol	C_6H_5SH	0.5	2	-	-	
Benzene- 1,2,4-tricarboxylic acid 1,2-anhydride	$C_9H_4O_5$	-	0.04	-	-	Sen
p-Benzoquinone	$C_6H_4O_2$	0.1	0.4	0.3	1.2	
Benzoyl peroxide	$(C_6H_5CO)_2O_2$	-	5	-	-	
Benzyl butyl phthalate	$C_6H_5CH_2COOC_6H_4$-$COOC_4H_9$	-	5	-	-	
Benzyl chloride	$C_6H_5CH_2Cl$	1	5	-	-	
Beryllium	Be	-	0.002	-	-	
Biphenyl	$(C_6H_5)2$	0.2	1.5	0.6	4	
2,2-Bis(p-methoxyphenyl)-1,1,1-trichloroethane	$C_{14}H_9Cl_5$	-	1	-	3	
Bis(2,3-epoxypropyl) ether		0.1	0.6	-	-	
Bis(2-ethylhexyl phthalate)	$C_6H_4.(COOCH_2CH(C_2H_5)$-$C_4H_9)_2$	-	5	-	10	
2,2-Bis(p-metho-xyphenyl) -1,1,1-trichloroethane	$C_{16}H_{15}Cl_3O_2$	-	10	-	-	
Bismuth telluride	Bi_2Te_3	-	10	-	20	
Bismuth telluride, seleniumdoped	Bi_2Te_3	-	5	-	10	
Borates, (tetra) sodium salts						
anhydrous	$Na_2B_4O_7$	-	1	-	-	
decahydrate	$Na_2B_4O_7.10H_2O$	-	5	-	-	
pentahydrate	$Na_2B_4O_7.5H_2O$	-	1	-	-	
Bornan-2-one	$C_{10}H_{16}O$	2	12	3	18	
Boron oxide	B_2O_3	-	10	-	20	
Boron tribromide	BBr_3	-	-	1	10	
Boron trifluoride	BF_3	-	-	1	3	
Bromacil (ISO)	$C_9H_{13}BrN_2O_2$	1	10	2	20	

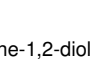
Bromine	Br_2	0.1	0.7	0.3	2	
Bromine pentafluoride	BrF_5	0.1	0.7	0.3	2	
Bromochloromethane	CH_2BrCl	200	1050	250	1300	
Bromoethane	C_2H_5Br	200	890	250	1110	
Bromoethylene	CH_2=$CHBr$	5	20	-	-	
Bromoform	$CHBr_3$	0.5	5	-	-	Sk
Bromomethane	CH_3Br	5	20	15	60	Sk
Bromotrifluoromethane	CF_3Br	1000	6100	1200	7300	
Butane	C_4H_{10}	600	1430	750	1780	
Butan-1 -ol	$CH_3CH_2CH_2CH_2OH$	-	-	50	150	Sk
Butan-2-ol	$CH_3CH_2CHOHCH_3$	100	300	150	450	
Butan-2-one	$CH_3COC_2H_5$	200	590	300	885	
trans-But-2-enal	CH_3CH=$CHCHO$	2	6	6	18	
Butyl acetate	$CH_3COO(CH_2)_3CH_3$	150	710	200	950	
sec-Butyl acetate	$CH_3COOCH(CH_3)CH_2CH_3$	200	950	250	1190	
tert-Butyl acetate	$CH_3COOC(CH_3)_3$	200	950	250	1190	
Butyl acrelate	$C_7H_{12}O_2$	10	55	-	-	
n-Butyl alcohol	$CH_3CH_2CH_2CH_2OH$	-	-	50	150	Sk
sec-Butyl alcohol	$CH_3CH_2CHOHCH_3$	100	300	150	450	Sk
tert-Butyl alcohol	$(CH_3)_3COH$	100	300	150	450	
n-Butylamine	$CH_3CH_2CH_2CH_2NH_2$	-	-	5	15	
Butyl benzyl phthalate	$C_6H_5CH_2COOC_6H_4$-$COOC_4H_9$	-	5	-	-	
n-Butyl chloroformate	$ClCO_2C_4H_{10}$	1	5.6	-	-	
Butyl-2,3-epoxy-propyl ether	$C_4H_9OCH_2\underbrace{CHCH_2}O$	25	135	-	-	
n-Butyl glycidyl ether (BGE)	$C_4H_9OCH_2\underbrace{CHCH_2}O$	25	135	-	-	
Butyl lactate	$C_7H_{14}O_3$	5	25	-	-	
2-sec-Butylphenol	$C_2H_5(CH_3)CHC_6H_4OH$	5	30	-	-	Sk
Caesium hydroxide	CsOH	-	2	-	-	
Calcium carbonate	$CaCO_3$					
total inhalable dust		-	10	-	-	
respirable dust		-	5	-	-	
Calcium cyanamide	CaNC=N	-	0.5	-	1	
Calcium hydroxide	$Ca(OH)_2$	-	5	-	-	
Calcium oxide	CaO	-	2	-	-	
Calcium silicate						
total inhalable dust		-	10	-	-	
respirable dust		-	5	-	-	
Camphor, synthetic	$C_{10}H_{16}O$	2	12	3	18	
ε-Caprolactam	$\underbrace{NH(CH_2)_5CO}$					
dust		-	1	-	3	
vapour		5	20	10	40	
Captafol (ISO)	$C_{10}H_9Cl_4NO_2S$	-	0.1	-	-	Sk
Captan (ISO)	$C_9H_8Cl_3NO_2S$	-	5	-	15	
Carbaryl (ISO)	$C_{10}H_7OCONHCH_3$	-	5	-	10	
Carbuforan (ISO)	$C_{12}H_{15}NO_3$	-	0.1	-	-	
Carbon black	C	-	3.5	-	7	
Carbon dioxide	CO_2	5000	9000	15000	27000	
Carbon monoxide	CO	50	55	300	330	
Carbon tetrabromide	CBr_4	0.1	1.4	0.3	4	
Carbon tetrachloride	CCl_4	2	12.6	-	-	Sk
Carbonyl chloride	$COCl_2$		0.4	-	-	Sk
Catechol	$C_6H_4(OH)_2$	5	20	-	-	
Cellulose						
total inhalable dust		-	10	-	20	
respirable dust	-	5	-	-		
Cement						
total inhalable dust	-	-	10	-		
respirable dust	-	-	5	-		
Chlordane (ISO)	$C_{10}H_6Cl_8$	-	0.5	-	2	Sk
Chlorinated biphenyls (42% chlorine)	$C_{12}H_7Cl_3$(approx)	-	1	-	2	Sk Sk
Chlorinated biphenyls (54% chlorine)	$C_6H_2Cl_3C_6H_3Cl_2$	-	0.5	-	1	Sk Sk
Chlorine	Cl_2	0.5	1.5	1	3	
Chlorine dioxide	ClO_2	0.1	0.3	0.3	0.9	
Chlorine trifluoride	ClF_3	-	-	0.1	0.4	
Chloroacetaldehyde	$ClCH_2CHO$	-	-	1	3	
2-Chloroacetophenone	$C_6H_5COCH_2Cl$	0.05	0.3	-	-	
Chloroacetyl chloride	$ClCH_2COCl$	0.05	0.2	-	-	
Chlorobenzene	C_6H_5Cl	50	230	-	-	

Chlorobromomethane	CH_2BrCl	200	1050	250	1300	
2-Chlorobuta-1,3-diene	CH_2=$CClCH$=CH_2	10	36	-	-	Sk
Chlorodifluoromethane	$CHClF_2$	1000	3500	-	-	
1-Chloro-2,3-epoxy-propane		2	8	5	20	Sk
Chloroethane	C_2H_5Cl	1000	2600	1250	3250	
2-Chloroethanol	$ClCH_2CH_2OH$	-	-	1	3	Sk
Chloroethylene	CH_2=$CHCl$ +	7	-	-	-	
Chloroform	$CHCl_3$	2	9.8	-	-	Sk
Chloromethane	CH_3Cl	50	105	100	210	
1-Chloro-4-nitrobenzene	$ClC_6H_4NO_2$	-	1	-	2	Sk
Chloropentafluoroethane	$CClF_2CF_3$	1000	6320	-	-	
Chloropicrin	CCl_3NO_2	0.1	0.7	0.3	2	
β-Chloroprene	CH_2=$CClCH$=CH_2	10	36	-	-	Sk
3-Chloropropene	CH_2=$CHCH_2Cl$	1	3	2	6	
Chlorosulphonic acid	HSO_3Cl	-	1	-	-	
a-Chlorotoluene	$C_6H_5CH_2Cl$	1	5	-	-	
2-Chlorotoluene	C_7H_7Cl	50	250	-	-	
2-Chloro-6-(trichloromethyl) pyridine	$C_6H_3Cl_4N$	-	10	-	20	
Chlorpyrifos (ISO)	$C_9H_{11}Cl_3NO_3PS$	-	0.2	-	0.6	Sk
Chromium	Cr	-	0.5	-	-	
Chromium(II) compounds (as Cr)	Cr	-	0.5	-	-	
Chromium(III) compounds (as Cr)	Cr	-	0.5	-	-	
Coal dust						
respirable dust		-	2	-	-	
Coal tar pitch volatiles (as cyclohexane solubles)		-	0.14	-	-	
Cobalt and compounds (as Co)	Co	-	0.1	-	-	
Copper	Cu					
fume		-	0.2	-	-	
dusts and mists (as Cu)		-	1	-	2	
Cotton dust	See Annexure 4	-	0.5	-	-	
Cresols, all isomers	$CH_3C_6H_4OH$	5	22	-	-	Sk
Cristobalite, respirable dust	SiO_2					
Crotonaldehyde	CH_3CH=$CHCHO$	2	6	6	18	
Cryofluorane (INN)	$CClF_2CClF_2$	1000	7000	1250	8750	
Cumene	$C_6H_5CH(CH_3)_2$	25	120	75	370	Sk
Cyanamide	H_2NCN	-	2	-	-	
Cyanides, except hydrogen cyanide, cyanogen & cyanogen chloride, (as-CN)		-	5	-	-	Sk
Cyanogen	$(CN)_2$	10	20	-	-	
Cyanogen chloride	$ClCN$	-	-	0.3	0.6	
Cychlohexane	C_6H_{12}	100	340	300	1030	
Cyclohexanol	$C_6H_{11}OH$	50	200	-	-	
Cyclohexanone	$C_6H_{10}O$	25	100	100	400	
Cyclohexene	C_6H_{10}	300	1015	-	-	
Cyclohexylamine	$C_6H_{11}NH_2$	10	40	-	-	Sk
Cyclonite (RDX)	$C_3H_6N_6O_6$	-	1.5	-	3	Sk
Cyhexatin (ISO)	$(C_6H_{11})_3SnOH$	-	5	-	10	

Substance	Formula	TWA OEL-RL		SHORT TERM OEL-RL		1995
		ppm	mg/m^3	ppm	mg/m^3	Notes
2,4D (ISO)	$C_6H_3Cl_2OCH_2COOH$	-	10	-	20	
DDM	$H_2NC_6H_4CH_2C_6H_4NH_2$	0.1	0.8	0.5	4	
DDT	$C_{14}H_9Cl_5$	-	1	-	3	
DDVP	$(CH_3O)_2POOCH$=CCl_2	0.1	1	-	3	Sk
2,4-DES	$C_8H_7Cl_2NaO_5S$	-	10	-	20	
DMDT	$C_{16}H_{15}Cl_3O_2$	-	10	-	-	
Derris, commercial	$C_{23}H_{22}O_6$	-	5	-	10	
Diacetone alcohol	$CH_3COCH_2C(CH_3)_2OH$	50	240	75	360	
Dialkyl 79 phthalate	$C_6H_4(COOC_{7\text{-}9}\ H_{15\text{-}19})_2$	-	5	-	-	
Dialkyl phthalate	$C_6H_4(COOCH_2CHCH)_2$	-	5	-	-	
2,2'-Diaminodi-ethylamine	$(NH_2CH_2CH_2)_2NH$	1	4	-	-	Sk
4-4'-Diaminodiphenyl-methane (DADPM)	$H_2NC_6H_4CH_2C_6H_4NH_2$	0.1	0.8	0.5	4	
1,2-Diaminoethane	$NH_2CH_2CH_2NH_2$	10	25	-	-	
Diammonium peroxodisulphate (measured as (S_2O_8))	$(NH_4)_2S_2O_8$	-	1	-	-	
Diatomaceous earth, natural respirable		-	1.5	-	-	

dust						
Diazinon (ISO)	$C_{12}H_{21}N_2O_3PS$	-	0.1	-	0.3	Sk
Diazomethane	$CH_2=N_2$	0.2	0.4	-	-	
Dibenzoyl peroxide	$(C_6H_5CO)_2O_2$	-	5	-	-	
Dibismuth tritelluride	Bi_2Te_3	-	10	-	20	
Dibismuth tritelluride,	Bi_2Te_3	-	5	-	10	
selenium doped		-	-	-	10	
Diborane	B_2H_6	0.1	0.1	-	-	
Diboron trioxide	B_2O_3	-	10	-	20	
Dibrom	$C_4H_7Br_2Cl_2O_4P$	-	3	-	6	
1,2-Dibromo-2,2-dichloroethyl dimethyl phosphate	$C_4H_7Br_2Cl_2O_4P$	-	3	-	6	
Dibromodifluoro-methane	CBr_2F_2	100	860	150	1290	
Dibutyl hydrogen phosphate	$(n\text{-}C_4H_9O)_2(OH)PO$	1	5	2	10	
Di-n-butyl phosphate	$(n\text{-}C_4H_9O)_2(OH)PO$	1	5	2	10	
Dibutyl phthalate	$C_6H_4(CO_2C_4H_9)2$	-	5	-	10	
6,6'-Di-tert-butyl-4,4'-thiodi-m-cresol	$C_{22}H_{30}O_2S$	-	10	-	20	
Dichloroacetylene	$ClC{=}CCl$	-	-	0.1	0.4	
1,2-Dichlorobenzene	$C_6H_4Cl_2$	-	-	50	300	
1,4-Dichlorobenzene	$C_6H_4Cl_2$	25	150	50	300	
Dichlorodifluoro-methane	CCl_2F_2	1000	4950	1250	6200	
1,3-Dichloro-5,5-dimethylhydantoin	$C_5H_6Cl_2N_2O_2$	-	0.2	-	0.4	
Dichlorodiphenyl-trichloroethane	$C_{14}H_9Cl_5$	-	1	-	3	
1,1-Dichloroethane	CH_3CHCl_2	200	810	400	1620	
1,2-Dichloroethane	CH_2ClCH_2Cl	10	40	15	60	
1,1-Dichloroethylene	$CH_2=CCl_2$	10	40	-	-	
1,2-Dichloroethylene, *cis*:*trans* isomers 60:40	$ClCH{=}CHCl$	200	790	250	1000	
Dichlorofluoromethane	$CHCl_2F$	10	40	-	-	
2,4-Dichlorophenoxyacetic acid	$C_6H_3Cl_2OCH_2COOH$	-	10	-	20	
1,3-Dichloropropene, *cis* and *trans* isomers	$CHCl{=}CHCH_2Cl$	1	5	10	50	Sk
1,2-Dichloro-tetra-fluoroethane	$CClF_2CClF_2$	1000	7000	1250	8750	
Dichlorvos (ISO)	$(CH_3O)_2POOCH{=}CCl_2$	0.1	1	0.3	3	Sk
Dicyclohexyl phthalate	$C_6H_4(COOC_6H_{11})_2$	-	5	-	-	
Dicyclopentadiene	$C_{10}H_{12}$	5	30	-	-	
Dicyclopenta-dienyliron	$C_{10}H_{10}Fe$	-	10	-	20	
Dieldrin (ISO)	$C_{12}H_8Cl_6O$	-	0.25	-	0.75	Sk
Diethanolamine	$HO(CH_2)_2NH(CH_2)_2OH$	3	15	-	-	
Diethylamine	$(C_2H_5)_2NH$	10	30	25	75	
2-Diethylaminoethanol	$(C_2H_5)_2NCH_2CH_2OH$	10	50	-	-	Sk
Diethylene glycol	$(HOCH_2CH_2)_2O$	23	100	-	-	
Diethylene triamine	$(NH_2CH_2CH_2)_2OH$	1	4	-	-	Sk
Diethyl ether	$C_2H_5OC_2H_5$	400	1200	500	1500	
Di-(2-ethylhexyl) phthalate	$C_6H_4(COOCH_2CH(C_2H_5)\text{-}C_4H_9)_2$	-	5	-	10	
Diethyl ketone	$C_2H_5COC_2H_5$	200	700	250	875	
Diethyl phthalate	$C_6H_4(COOC_2H_5)_2$	-	5	-	10	
Difluorochloromethane	$CHClF_2$	1000	3500	-	-	
Diglycidyl ether (DGE)	$(OCH_2CHCH_2)_2O$	0.1	0.6	-	-	
o-Dihydroxybenzene	$C_6H_4(OH)$	5	20	-	-	
m-Dihydroxybenzene	$C_6H_4(OH)_2$	10	45	20	90	
p-Dihydroxybenzene	$C_6H_4(OH)_2$	-	2	-	4	
1,2-Dihydroxyethane	CH_2OHCH_2OH					
particulate		-	10	-	-	
vapour		-	60	-	125	
Diisobutyl ketone	$[(CH_3)_2CHCH_2]_2CO$	25	150	-	-	
Diisobutyl phthalate	$C_6H_4[COOCH_2CH(CH_3)_2]_2$	-	5	-	-	
Diisodecyl phthalate	$(C_{10}H_{21}CO_2)_2C_6H_4$	-	5	-	-	
Diisononyl phthalate	$C_6H_4(COOC_9H_{19})_2$	-	5	-	-	
Diisooctyl phthalate	$C_6H_4(CO_2C_8H_{17})_2$	-	5	-	-	
Diisopropylamine	$(CH_3)_2CHNHCH(CH_3)_2$	5	20	-	-	Sk
Diisoppropyl ether	$(CH_3)_2CHOCH(CH_3)_2$	250	1050	310	1320	
Di-linear 79 phthalate	$C_6H_4(COOC_{7\text{-}9}H_{15\text{-}19})_2$	-	5	-	-	
Dimethoxymethane	$CH_2(OCH_3)_2$	1000	3100	1250	3880	
NN-Dimethyl-acetamide	$CH_3CON(CH_3)_2$	10	36	20	71	Sk
Dimethylamine	$(CH_3)_2NH$	10	18	-	-	
NN-Dimethylaniline	$C_6H_5N(CH_3)_2$	5	25	10	50	Sk
1,3-Dimethylbutyl acetate	$CH_3CO_2CH(CH_3)CH_2CH\text{-}(CH_3)_2$	50	300	100	600	
NN-Dimethyl-ethylamine	$C_2H_5(CH_3)_2N$	10	30	15	45	
Dimethylformamide	$HCON(CH_3)_2$	10	30	20	60	Sk
2,6-Dimethylheptan-4-one	$[(CH_3)_2CHCH_2]_2CO$	25	150	-	-	
Dimethyl phthalate	$C_6H_4(COOCH_3)_2$	-	5	-	10	
Dimethyl sulphate	$(CH_3)_2SO_4$	0.1	0.5	0.1	0.5	Sk
Dinitrobenzene, all isomers	$C_6H_4(NO_2)_2$	0.15	1	0.5	3	Sk

Dinitro-o-cresol	$CH_3C_6H_2(OH)(NO_2)_2$	-	0.2	-	0.6	Sk
2,4-Dinitrotoluene	$CH_3C_6H_3(NO_2)_2$	-	1.5	-	5	Sk
Dinonyl phthalate	$C_6H_4(COOC_9H_{19})_2$	-	5	-	-	
Di-*sec*-octyl phthalate	$C_6H_4[COOCH_2CH(C_2H_5)\text{-}C_4H_9]_2$	-	5	-	10	
1,4-Dioxane, tech. grade		25	90	100	360	Sk
Dioxathion (ISO)	$C_{12}H_{26}O_6P_2S_2$	-	0.2	-	-	Sk
Diphenyl	$(C_6H_5)_2$	0.2	1.5	0.6	4	
Diphenylamine	$(C_6H_5)_2NH$	-	10	-	20	
Diphenyl ether (vapour)	$C_6H_5OC_6H_5$	1	7	-	-	
Diphosphorus pentasulphide	P_2S_5	-	1	-	3	
Dipotassium peroxodisulphate measured as (S_2O_8)	$K_2S_2O_8$	-	1	-	-	
Diquat dibromide (ISO)	$C_{12}H_{12}Br_2N_2$	-	0.5	-	1	
Disodium disulphite	$Na_2S_2O_5$	-	5	-	-	
Disodium peroxodisulphate (measured as (S_2O_8)	$Na_2S_2O_8$	-	1	-	-	
Disodium tetraborate,						
anhydrous	$Na_2B_4O_7$	-	1	-	-	
decahydrate	$Na_2B_4O_7.1OH_2O$	-	5	-	-	
pentahydrate	$Na_2B_4O_7.5H_2O$	-	1	-	-	
Disulfoton (ISO)	$(C_2H_5O)_2PSCH_2CH_2SC_2H_5$	-	0.1	-	0.3	
Disulphur dichloride	S_2Cl_2	-	-	1	6	
Disulphur decafluoride	S_2F_{10}	0.025	0.25	0.075	0.75	
2,6-Ditertiary-butyl-paracresol	$(C_4H_9)_2CH_3C_6H_2OH$	-	10	-	-	
Diuron (ISO)	$C_9H_{10}Cl_2N_2O$	-	10	-	-	
Divanadium pentaoxide (as V)	V_2O_5					
total inhalable dust		-	0.5	-	-	
fume and respirable dust		-	0.05	-	-	
Divinylbenzene	$C_8H_4.(CHCH_2)_2$	10	50	-	-	
Dusts	See paragraph 36 of Annexure 1					

Substance	Formula	TWA OEL-RL		SHORT TERM OEL-RL		1995
		ppm	mg/m^3	ppm	mg/m^3	Notes
Emery						
total inhalable dust		-	10	-	-	
respirable dust		-	5	-	-	
Endosulfan (ISO)	$C_9H_6Cl_6O_3S$	-	0.1	-	0.3	Sk
Endrin (ISO)	$C_{12}H_8Cl_6O$	-	0.1	-	0.3	Sk
Enflurane	CHFCl-CF2-O-CF_2H	20	150	-	-	
Epichlorohydrin		2	8	5	20	Sk
1,2-Epoxy-4-epoxyethyl-cyclohexane	$C_8H_{12}O_2$	10	60	-	-	
2,3-Epoxypropyl isopropyl ether		50	240	75	360	
Ethane-1,2-diol	CH_2OHCH_2OH					
particulate		-	10	-	-	
vapour		-	60	-	125	
Ethanethiol	C_2H_5SH	0.5	1	2	3	
Ethanol	C_2H_5OH	1000	1900	-	-	
Ethanolamine	$NH_2CH_2CH_2OH$	3	8	500	1500	
Ether	$C_2H_5OC_2H_5$	400	1200	-	-	
Ethyl acetate	$CH_3COOC_2H_5$	400	1400	-	-	
Ethyl acrylate	CH_2=$CHCOOC_2H_5$	5	20	15	60	Sk
Ethyl alcohol	C_2H_5OH	1000	1900	-	-	
Ethylamine	$C_2H_5NH_2$	10	18			
Ethyl amyl ketone	$CH_3CH_2COCH_2CH_3CHCH_2CH_3$	25	130	-	-	
Ethylbenzene	$C_6H_5C_2H_5$	100	435	125	545	
Ethyl bromide	C_2H_5Br	200	890	250	1110	
Ethyl butyl ketone	$CH_3CH_2CO(CH_2)_3CH_3$	50	230	75	345	
Ethyl chloride	C_2H_5Cl	1000	2600	1250	3250	
Ethyl chloroformate	$ClCO_2C_2H_5$	1	4.4	-	-	
Ethylene chlorohydrin	$ClCH_2CH_2OH$	-	-	1	3	Sk
Ethylenediamine	$NH_2CH_2CH_2NH_2$	10	25	-	-	
Ethylene dibromide	$BrCH_2CH_2Br$	0.5	4	-	-	Sk
Ethylene dichloride	CH_2ClCH_2Cl	10	40	15	60	
Ethylene dinitrate	$CH_2NO_3CH_2NO_3$	0.2	1.2	0.2	1.2	Sk
Ethylene glycol	CH_2OHCH_2OH					
particulate		-	10	-	-	

vapour		-	60	-	125	
Ethylene glycol dinitrate (EGDN)	$CH_2NO_3CH_2NO_3$	0.2	1.2	0.2	1.2	Sk
Ethylene glycol monobutyl ether	$C_4H_9OCH_2CH_2OH$	25	120	-	-	Sk
Ethylene glycol monoethyl ether	$C_2H_5OCH_2CH_2OH$	10	37	-	-	Sk
Ethylene glycol monoethyl ether acetate	$C_2H_5OCH_2CH_2OOCCH_3$	10	54	-	-	Sk
Ethylene glycol monomethyl ether acetate	$CH_3COOCH_2CH_2OCH_3$	5	24	-	-	Sk
Ethylene glycol monomethyl ether	$CH_3OCH_2CH_2OH$	5	16	-	-	Sk
Ethyleneimine	CH_2CH_2NH	0.5	1	-	-	Sk
Ethylene oxide	CH_2CH_2O	5	10	-	-	
Ethyl ether	$C_2H_5OC_2H_5$	400	1200	500	1500	
Ethyl formate	$HCOOC_2H_5$	100	300	150	450	
2-Ethylhexyl chloroformate	$ClCO_2CH_2CH(CH_2)_3CH_3$ C_2H_5	1	7.9	-	-	
Ethylidene dichloride	CH_3CHCl_2	200	810	400	1620	
Ethyl mercaptan	C_2H_5SH	0.5	1	2	3	
4-Ethylmorpholine	$C_6H_{13}NO$	5	23	20	95	Sk
Ethyl silicate	$Si(OC_2H_5)_4$	10	85	30	255	

Substance	Formula	TWA OEL-RL		SHORT TERM OEL-RL		1995
		ppm	mg/m^3	ppm	mg/m^3	Notes
Fenchlorphos (ISO)	$(CH_3O)_2PSOC_6H_2Cl_3$	-	10	-	-	
Ferbam (ISO)	$[(CH_3)_2NCSS]_3Fe$	-	10	-	20	
Ferrocene	$C_{10}H_{10}Fe$	-	10	-	20	
Fluoride (as F)	F	-	2.5	-	-	
Fluorine	F2	-	-	1	1.5	
Fluorodichloromethane	$CHCl_2F$	10	40	-	-	
Fluorotrichloromethane	CCl_3F	1000	5600	1250	7000	
Formamide	$HCONH_2$	20	30	30	45	
Formic acid	HCOOH	5	9	-	-	
2-Furaldehyde (Furfural)	$C_5H_4O_2$	2	8	10	40	Sk
Furfuryl alcohol	$OCH=CHCH=CCH_2OH$	5	20	15	60	Sk
Germane	GeH_4	0.2	0.6	0.6	1.8	
Germanium tetrahydride	GeH_4	0.2	0.6	0.6	1.8	
Glutaraldehyde	$OCH(CH_2)_3CHO$	-	-	0.2	0.7	
Glycerol, mist	$CH_2OHCHOHCH_2OH$	-	10	-	-	
Glycerol trinitrate	$CH_2NO_3CHNO_3CH_2NO_3$	0.2	2	0.2	2	Sk
Glycol monoethyl ether	$C_2H_5OCH_2CH_2OH$	10	37	0.2	2	Sk
Graphite	C					
total inhalable dust		-	10	-	-	
respirable dust		-	5	-	-	
Guthion	$(CH_3O)_2PSSCH_2(C_7H_4N_3O)$	-	0.2	0.6	-	Sk
Gypsum	$CaSO_4.2H_2O$					
total inhalable dust		-	10	-	-	
respirable dust		-	5	-	-	
Halothane	$CHBrCl\text{-}CF_3$	10	80	-	-	
y-HCH (ISO)	$C_6H_5Cl_6$	-	0.5	-	1.5	Sk
Hafnium	Hf	-	0.5	-	1.5	
Heptachlor	$C_{10}H_5Cl_7$	-	0.5	-	2	Sk
n-Heptane	C_7H_{16}	400	1600	500	2000	
Heptane-2-one	$CH_3.(CH_2)_4COCH_3$	50	240	-	-	
Heptan-3-one	$CH_3CH_2CO(CH_2)_3CH_3$	50	230	75	345	
y-Hexachlorocyclo-hexane	$C_6H_5Cl_6$	-	0.5	-	1.5	Sk
Hexachloroethane	CCl_3CCl_3					
vapour		5	50	-	-	
total inhalable dust		-	10	-	-	
respirable dust		-	5	-	-	
Hexahydro-1,3,5-trinitro-1,3,5-triazine	$C_3H_6N_6O_6$	-	1.5	-	3	Sk
Hexane, all isomers except n-Hexane	C_6H_{14}	500	1800	1000	3600	
n-Hexane	C_6H_{14}	20	70	-	-	
1,6 Hexanolactam	$NH(CH_2)_5CO$					

dust		-	1	-	3	
vapour		5	20	10	40	
Hexan-2-one	$CH_3(CH_2)_3COCH_3$	5	20	-	-	Sk
Hexone	$(CH_3)_2CHCH_2COCH_3$	50	205	75	300	Sk
Hexylene glycol	$(CH_3)_2COHCH_2CHOHCH_3$	25	125	25	125	
Hydrazine	NH_2NH_2	0.1	0.1	-	-	Sk
Hydrazoic acid (as vapour)	NH_3	-	-	0.1	-	
Hydrogen bromide	HBr	-	-	3	10	
Hydrogen chloride	HCl	-	-	5	7	
Hydrogenfluoride (as F)	HF	-	-	3	2.5	
Hydrogen peroxide	H_2O_2	1	1.5	2	3	
Hydrogen selenide (as Se)	H_2Se	0.05	0.2	-	-	
Hydrogen sulphide	H_2S	10	14	15	21	
Hydroquinone	$C_6H_4(OH)_2$	-	2	-	4	
4-Hydroxy-4-methyl-pentan-2-one	$CH_3COCH_2C(CH_3)_2OH$	50	240	75	360	
2-Hydroxypropyl acrylate	$CH_2CHOOCH_2CHOHCH_3$	0.5	3	-	-	Sk
2,2'-Iminodiethanol	$HO(CH_2)_2NH(CH_2)_2OH$	3	15	-	-	
2,2'-Iminodi (ethylamine)	$(NH_2CH_2CH_2)_2NH$	1	4	-	-	Sk
Indene	C_9H_8	10	45	15	70	
Indium & compounds (as In)	In	-	0.1	-	0.3	
Iodine	I_2	-	-	0.1	1	
Iodoform	CHI_3	0.6	10	1	20	
Iodomethane	CH_3I	5	28	10	56	Sk
Iron oxide, fume (a Fe)	Fe_2O_3	-	5	-	10	
Iron pentacarbonyl	$FE(CO)_5$	0.01	0.08	-	-	
Iron salts (as Fe)	Fe	-	1	-	2	
Isoamyl acetate	$CH_3COOCH_2CH_2CH(CH_3)_2$	100	525	125	655	
Isoamyl alcohol	$(CH_3)_2CHCH_2CH_2OH$	100	360	125	450	
Isoamyl methyl ketone	$CH_3COCH_2CH_2CH(CH_3)_2$	50	240	75	360	
Isobutyl acetate	$CH_3COOCH_2CH(CH_3)_2$	150	700	187	875	
Isobutyl alcohol	$(CH_3)_2CHCH_2OH$	50	150	75	225	
Isobutyl methyl ketone	$(CH_3)_2CHCH_2COCH_3$	50	205	75	300	Sk
Isoflurane	CF_3-CHCl-O-CHF_2	50	380	-	-	
Isooctyl alcohol (mixed isomers)	$C_8H_{17}OH$	50	270	-	-	
Isopentyl acetate	$CH_3COOCH_2CH_2CH(CH_3)_2$	100	525	125	655	
Isophorone	$C_9H_{14}O$	-	-	5	25	
Isophorone diisocyanate (IPDI)		-	0.2	-	0.07	Sen
Isopropyl acetate	$CH_3COOCH(CH_3)_2$	-	-	200	840	
Isopropyl alcohol	$(CH_3)_2CHOH$	400	980	500	1225	Sk
Isopropyl benzene	$C_6H_5CH(CH_2)_2$	25	120	75	370	Sk
Isopropyl chloroformate	$ClCO_2CH(CH_3)_2$	1	5	-	-	
Isopropyl ether	$(CH_3)_2CHOCH(CH_3)_2$	250	1050	310	1320	
Isopropyl glycidyl ether (IGE)	$C_3H_7OCH_2CHCH_2$ (O)	50	240	75	360	
Ketene	CH_2=CO	0.5	0.9	1.5	3	
Limestone						
total inhalable dust		-	10	-	-	
respirable dust		-	5	-	-	
Lindane	$C_6H_5Cl_6$	-	0.5	-	1.9	Sk
Liquified petroleum gas (LPG)	Mixture: C_3H_6;C_3H_8;C_4H_8;C_4H_{10}	1000	1800	1250	2250	
Lithium hydride	LiH	-	0.025	-	-	
Lithium hydroxide	LiOH	-	-	-	1	

Substance	Formula	TWA OEL-RL		SHORT TERM OEL-RL		1995
		ppm	mg/m^3	ppm	mg/m^3	Notes
MbOCA	$CH_2(C_6H_3ClNH_2)_2$	-	0.005	-	-	Sk
MDA	$H_2NC_6H_4CH_2C_6H_4NH_2$	0.1	0.8	0.5	4	
MDI						
Magnesite						
total inhalable dust		-	10	-	-	
respirable dust		-	5	-	-	
Magnesium oxide (as Mg)	MgO					
fume and respirable dust		-	5	-	10	
respirable dust		-	10	-	-	
Malathion (ISO)	$C_{10}H_{19}O_6PS_2$	-	10	-	-	Sk
Maleic anhydride	$C_4H_2O_3$	0.25	1	-	-	
Manganese, fume (as Mn)	Mn	-	1	-	3	
Manganese and compounds (as Mn)	Mn	-	5	-	-	

Manganese cyclopentadienyl tricarbonyl	C_5HC_5-$MN(CO)_3$	-	0.1	-	0.3	Sk
Manganese tetroxide	Mn_3O_4	-	1	-	-	
*Man made mineral fibre	See Annexure 3					
Marble						
total inhalable dust		-	10	-	-	
respirable dust		-	5	-	-	
Mequinol (INN)	$CH_3OC_6H_4OH$	-	5	-	-	
Mercaptoacetic acid	$C_2H_4O_2S$	1	5	-	-	
Mercury alkyls (as Hg)		-	0.01	-	0.03	Sk
Mercury & compounds, except mercury alkyls, (as Hg)	Hg	-	0.05	-	0.15	
Mesityl oxide	$CH_3COCH=C(CH_3)_2$	15	60	25	100	
Methacrylic acid	$CH_2=C(CH_3)COOH$	20	70	40	140	
Methacrylonitrile	$CH_2=C(CH_3)CN$	1	3	-	-	Sk
Methanethiol	CH_3SH	0.5	1	-	-	
Methanol	CH_3OH	200	260	250	310	Sk
Methomyl (ISO)	$C_5H_{10}N_2O_2S$	-	2.5	-	-	Sk
Methoxychlor (ISO)	$C_{16}H_{15}Cl_3O_2$	-	10	-	-	
1-Methoxypropan-2-ol	$CH_3OCH_2CHOHCH_3$	100	360	300	1080	Sk
Methyl acetate	CH_3COOCH_3	200	610	250	760	
Methyl acrylate	$CH_2=CHCOOCH_3$	10	35	-	-	
Methylal	$CH_2(OCH_3)_2$	1000	3100	1250	3880	
Methyl alcohol	CH_3OH	200	260	250	310	Sk
Methylamine	CH_3NH_2	10	12	-	-	
Methyl-n-amyl-ketone	$CH_3(CH_2)_4COCH_3$	50	240	-	-	
N-Methylaniline	$C_6H_5NHCH_3$	0.5	2	-	-	Sk
Methyl bromide	CH_3Br	5	20	15	60	Sk
3-Methylbutan-1-ol	$(CH_3)_2CHCH_2CH_2OH$	100	360	125	450	
1-Methylbutyl acetate	$CH_3COOCH(CH_3)C_3H_7$	-	-	150	800	

* The OEL-RL for man-made mineral fibre is set at 2 fibres m^{-1}, 8 hour TWA, when measured by the AIA RTM1 method.

Substance	Formula	TWA OEL-RL		SHORT TERM		1995
		ppm	mg/m^3	ppm	mg/m^3	Notes
Methyl-n-butyl ketone	$CH_3.(CH_2)_3COCH_3$	5	20	-	-	Sk
Methyl chloride	CH_3Cl	50	105	100	210	
Methyl chloroform	CH_3CCl_3	350	1900	450	2450	
Methyl 2-cyanoacrylate	$CH_2=C(CN)COOCH_3$	2	8	4	16	
Methylcyclohexane	C_7H_{14}	400	1600	500	2000	
Methylcyclohexanol	$CH_3C_6H_{10}OH$	50	235	75	350	
2-Methylcyclo-hexanone	$CH_3CHCO(CH_2)_3CH_2$	50	230	75	345	Sk
Methylcyclo-pentadienyl manganese, tricarbonyl (as Mn)	C_5HC_5-$Mn(CO)_3$ $(CH_3)C_5H_4$-$Mn(CO)_3$	-	0.1	-	0.6	Sk
2-Methyl-4,6-dinitrophenol	$CH_3C_6H_2.(OH)(NO_2)_2$	-	0.2	-	0.6	Sk
4,4'-Methylenebis-(2-chloroaniline) (MbOCA)	$CH_2(C_6H_3ClNH_2)_2$	-	0.005	-	-	Sk
Methylene chloride	CH_2Cl_2	100	350	250	780	
4,4'-Methylene-diphenyl diisocyanate (MDI)		-	0.02	-	0.07	Sen
4,4'-Methylenedianiline (MDA)	$H_2NC_6H_4CH_2C_6H_4NH_2$	0.1	0.8	0.5	4	
Methyl ethyl ketone (MEK)	$CH_3COC_2H_5$	200	590	300	885	
Methyl ethyl ketone peroxides (MEKP)	$C_8H_{16}O_4$ or $C_8H_{18}O_6$	-	-	0.2	1.5	
Methyl formate	$HCOOCH_3$	100	250	150	375	
5-Methylheptan-3-one	$CH_3CH_2COCH_2CH_3$-$CHCH_2CH_3$	25	130	-	-	
5-Methylhexan-2-one	$CH_3COCH_2CH_2CH_2.(CH_3)_2$	50	240	75	360	
Methyl iodide	CH_3I	5	28	10	56	Sk
Methyl isoamyl ketone	$CH_3COCH_2CH_2CH(CH_3)_2$	50	240	75	360	
Methyl isobutyl carbinol	$CH_3CHOHCH_2CH(CH_3)_2$	25	100	40	160	Sk
Methyl isobutyl ketone (MIBK)	$(CH_3)_2CHCH_2COCH_3$	50	205	75	300	Sk
Methyl isocyanate		-	0.02	-	0.07	Sen
Methyl mercaptan	CH_3SH	0.5	1	-	-	
Methyl methacrylate	$CH_2=C(CH_3)COOCH_3$	100	410	125	510	
Methyl parathion	$C_8H_{10}NO_5PS$	-	0.2	-	0.6	Sk
2-Methylpentane-2,4-diol	$(CH_3)_2COHCH_2CHOHCH_3$	25	125	25	125	
4-Methylpentan-2-ol	$CH_3CHOHCH_2CH(CH_3)_2$	25	100	40	160	Sk

4-Methylpentan-2-one	$(CH_3)_2CHCH_2COCH_3$	50	205	75	300	Sk
4-Methylpent-3-and-2-one	$CH_3COCH=C(CH_3)_2$	15	60	25	100	
4-Methyl-m-phenylene diisocyanate		-	0.02	-	0.07	Sen
2-Methylpropan-1-ol	$(CH_3)_2CHCH_2OH$	50	150	75	225	
2-Methylpropan-2-ol	$(CH_3)_3COH$	100	300	150	450	
Methyl propyl ketone	$CH_3COC_3H_7$	200	700	250	875	
1-Methyl-2-pyrrolidone	$CH_3N(CH_2)_3CO$	100	400	-	-	
Methyl silicate	$(CH_3O)_4Si$	1	6	5	30	
a-Methylstyrene	$C_6H_5C(CH_3)=CH_2$	-	-	100	480	
Methylstyrenes, all isomers except *a*-methylstyrene	$CH_3C_6H_4CH=CH_2$	100	480	150	720	
N-Methyl-N, 2,4,6-tetranitroaniline	$(NO_2)_3C_6H_2N(NO_2)CH_3$	-	1.5	-	3	Sk
Mevinphos (ISO)	$C_7H_{13}O_6P$	0.01	0.1	0.03	0.3	Sk
Mica						
total inhalable dust		-	10	-	-	
respirable dust		-	1	-	-	
Molybdenum compounds (as Mo)	Mo					
soluble compounds		-	5	-	10	
insoluble compounds		-	10	-	20	
Monochloroacetic acid	$ClCH_2CO_2H$	0.3	1	-	-	Sk
Morpholine	C_4H_9NO	20	70	30	105	Sk
Naled (ISO)	$C_4H_7Br_2Cl_2O_4P$	-	3	-	6	
Naphtalene	$C_{10}H_8$	10	50	15	75	
1,5-Naphtylene diisocyanate		-	0,02	-	0.07	Sen
Nickel carbonyl	$Ni(CO)_4$	-	-	0.1	0.24	
Nickel, organic compounds (as Ni)	Ni	-	1	-	3	
Nicotine	$C_{10}H_{14}N_2$	-	0.5	-	1.5	Sk
Nitrapyrin	$C_6H_3Cl_4N$	-	10	-	20	
Nitric acid	HNO_3	2	5	4	10	
Nitric oxide	NO	25	30	35	45	
4-Nitroaniline	$NO_2C_6H_4NH_2$	-	6	-	-	Sk
Nitrobenzene	$C_6H_5NO_2$	1	5	2	10	Sk
Nitroethane	$C_2H_5NO_2$	100	310	-	-	
Nitrogen dioxide	NO_2	3	5	5	9	
Nitrogen monoxide	NO	25	30	35	45	
Nitrogen trifluoride	NF_3	10	30	15	45	
Nitroglycerine	$CH_2NO_2CHNO_3CH_2NO_3$	0.2	2	0.2	2	Sk
Nitromethane	CH_3NO_2	100	250	150	375	
1-Nitropropane	$C_3H_7NO_2$	25	90	-	-	
2-Nitropropane	$CH_3CH(NO_2)CH_3$	10	36	20	72	
Nitrotoluene, all isomers	$CH_3C_6H_4NO_2$	5	30	10	60	Sk
Nitrous oxide	N_2O	100	180	-	-	
Octachloronaphtalene	$C_{10}Cl_8$	-	0.1	-	0.3	Sk
n-Octane	$CH_3.(CH_2)_6CH_3$	300	1450	375	1800	
Orthophosphoric acid	H_3PO_4	-	1	-	3	
Osmium tetraoxide (as Os)	OsO_4	0.0002	0.0002	0.0006	0.0006	
Oxalic acid	COOHCOOH	-	1	-	2	
Oxalonitrile	$(CN)_2$	10	20	-	-	
2,2'-Oxydiethanol	$(HOCH_2CH_2)_2O$	23	100	-	-	
Ozone	O_3	0.1	0.2	0.3	0.6	

Substance	Formula	TWA OEL-RL		SHORT TERM OEL-RL		1995
		ppm	mg/m^3	ppm	mg/m^3	Notes
PCBs						
Chlorinated biphenyls (42% chlorine)	$C_{12}H_7Cl_3$ (approx)	-	1	-	2	Sk
Chlorinated biphenyls (54% chlorine)	$C_6H_2Ci_3C_6H_3Cl_2$	-	0.5	-	1	Sk
Paraffin wax, fume		-	2	-	6	
Paraquat dichloride (ISO)	$[CH_3(C_5H_4N_+)_2CH_3]$					
respirable dust	$(Cl\text{-}_2)$	-	0.1	-	-	
Parathion (ISO)	$(C_2H_5O)_2PSOC_6H_4NO_2$	-	0.1	-	0.3	Sk
Parathion-methyl (ISO)	$C_8H_{10}NO_5PS$	-	0.2	-	0.6	Sk
Pentacarbonyliron (as Fe)	$FE(CO)_5$	0.01	0.08	-	-	
Pentachlorophenol	C_6Cl_5OH	-	0.5	-	1.5	Sk
Pentaerythritol	$C(CH_2OH)_4$					
total inhalable dust		-	10	-	20	
respirable dust		-	5	-	-	

Pentane, all isomers	C_5H_{12}	600	1800	750	2250	
Pentan-2-one	$CH_3COC_3H_7$	200	700	250	875	
Pentan-3-one	$C_2H_5COC_2H_5$	200	700	250	875	
Pentyl acetate	$CH_3COOC_5H_{11}$	100	530	150	800	
Perchloroethylene	$CCl=CCl_2$	50	335	150	1000	
Perchloryl fluoride	ClO_3F	3	14	6	28	
Phenacyl chloride	$C_6H_5COCH_2Cl$	0.05	0.3	-	-	
Phenol	C_6H_5OH	5	19	10	38	Sk
p-Phenylenediamine	$C_6H_4(NH_2)_2$	-	0.1	-	-	Sk
Phenyl-2,3-epoxypropyl ether	$C_6H_5OCH_2CHCH_2$ \ / O	1	6	-	-	
Phenylethylene	$C_6H_5CH=CH_2$	100	420	250	1050	
Phenylhydrazine	$C_6H_5NHNH_2$	5	20	10	45	Sk
2-Phenylpropene	$C_6H_5C(CH_3)=CH_2$	-	-	100	480	
Phorate (ISO)	$C_7H_{17}O_2PS_3$	-	0.05	-	0.2	Sk
Phosdrin	$C_7H_{13}O_6P$	0.01	0.1	0.03	0.3	Sk
Phosgene	$COCl_2$	0.1	0.4	-	-	
Phosphine	PH_3	-	-	0.3	0.4	
Phosphorus, yellow	P4	-	0.1	-	0.3	
Phosphorus pentachloride	PCl_5	0.1	1	-	-	
Phosphorus pentasulphide	P_2S_5	-	1	-	3	
Phosphorus trichloride	PCl_3	0.2	1.5	0.5	3	
Phosporyl trichloride	$POCl_3$	0.2	1.2	0.6	3.6	
Phthalic anhydride	$C_6H_4(CO)_2O$	1	6	4	24	Sen
Picloram (ISO)	$C_6H_3Cl_3N_2O_2$					
Picric acid	$HOC_6H_2(NO_2)_3$	-	0.1	-	0.3	Sk
Piperazine dihydrochloride	$C_4H_{10}N_2.2HCl$	-	5	-	-	
Piperidine	$C_5H_{11}N$	1	3.5	-	-	Sk
Plaster of Paris	$(CaSO_4)_2.H_2O$					
total inhalable dust		-	10	-	-	
respirable dust		-	5	-	-	
Platinum metal	Pt	-	5	-	-	
Platinum salts, soluble (as Pt)	Pt	-	0.002	-	-	Sen
Polychlorinated biphenyls (PCBs)	See PCB's					
Polyvinyl chloride (PVC)						
total inhalable dust		-	10	-	-	
respirable dust		-	5	-	-	
Portland Cement						
total inhalable dust		-	10	-	-	
respirable dust		-	5	-	-	
Potassium hydroxide	KOH	-	-	-	2	
Propane-1,2-diol	$CH_3CHOHCH_2OH$					
total (vapour and particulates)		150	470	-	-	
particulates		-	10	-	-	
n-Propanol	$CH_3CH_2CH_2OH$	200	500	250	625	Sk
Propan-1-ol	$CH_3CH_2CH_2OH$	200	500	250	625	Sk
Propan-2-ol	$(CH_3)_2CHOH$	400	980	500	1225	Sk
Propargyl alcohol	$HC=CCH_2OH$	1	2	3	6	Sk
Propionic acid	CH_3CH_2COOH	10	30	15	45	
Propoxur (ISO)	$H_3CNHCOOC_6H_4OCH\text{-}(CH_3)_2$	-	0.5	-	2	
n-Propyl acetate	$CH_3COOC_3H_7$	200	840	250	1050	
Propylene dinitrate	$CH_2NO_3CHNO_3CH_3$	0.2	1.2	0.2	1.2	Sk
Propylene glycol	$CH_3CHOHCH_2OH$					
total (vapour and particulates)		150	470	-	-	
particulates		-	10	-	-	
Propylene glycol dinitrate (PGDN)	$CH_2NO_3CHNO_3CH_3$	0.2	1.2	0.2	1.2	Sk
Propylene glycol monomethyl ether	$CH_3OCH_2CHOHCH_3$	100	360	300	1080	Sk
Prop-2-yn-1-ol	$HC=CCH_2OH$	1	2	3	6	Sk
Pulverised Fuel Ash						
total inhalable dust	-	10	-	-		
respirable dust	-	5	-	-		
Pyrethrins (ISO)	-	5	-	10		
Pyridine	C_5H_5N	5	15	10	30	
2-Pyridylamine	$NH_2C_5H_4N$	0.5	2	2	8	
Pyrocatechol	$C_6H_4(OH)_2$	5	20	-	-	
Quartz, crystalline	SiO_2					
respirable dust		-	0.4	-	-	
Quinone	$C_6H_4O_2$	0.1	0.4	0.3	1.2	

Substance	Formula	TWA OEL-RL	SHORT TERM OEL-RL	1995

		ppm	mg/m^3	ppm	mg/m^3	Notes
RDX	$C_3H_6N_6O_6$	-	1.5	-	3	Sk
Resorcinol	$C_6H_4(OH)_2$	10	45	20	90	
Rhodium (as Rh),	Rh					
metal fume and dust		-	0.1	-	0.3	
soluble salts		-	0.001	-	0.003	
Ronnel	$(CH_3O)_2PSOC_6H_2Cl_3$	-	10	-	-	
Rosin core solder pyrolysis products as formaldehyde		-	0.1	-	0.3	Sen
Rotenone (ISO)	$C_{23}H_{22}O_6$	-	5	-	10	
Rouge						
total inhalable dust		-	10	-	-	
respirable dust		-	5	-	-	
Selenium and compounds, except hydrogen selenide (as Se)	Se	-	0.1	-	-	
Silane	SiH_4	0.5	0.7	1	1.5	
Silica, amorphous	SiO_2					
total inhalable dust		-	6	-	-	
respirable dust		-	3	-	-	
Silica, fused	SiO_2					
respirable dust		-	0.1	-	-	
Silicon	Si					
total inhalable dust		-	10	-	-	
respirable dust		-	5	-	-	
Silicon carbide	SiC					
total inhalable dust		-	10	-	-	
respirable dust		-	5	-	-	
Silicon tetrahydride	SiH_4	0.5	0.7	1	1.5	
Silver	Ag	-	0.1	-	-	
Silver compounds (as Ag)	Ag	-	0.01	-	-	
Sodium azide	NaN_3	-	-	-	0.3	
Sodium 2-(2,4-dichloro-phenoxy) ethyl sulphate	$C_8H_7Cl_2NaO_5S$	-	10	-	20	
Sodium fluoroacetate	$CH_2FCOONa$	-	0.05	-	0.15	Sk
Sodium hydrogensulphite	$NaHSO_3$	-	5	-	-	
Sodium hydroxide	NaOH	-	-	-	2	
Sodium metabisulphate	$Na_2S_2O_5$	-	5	-	-	
Starch						
total inhalable dust		-	10	-	-	
respirable dust		-	5	-	-	
Stibine	SbH_3	0.1	0.5	0.3	1.5	
Strychnine	$C_{21}H_{22}N_2O_2$	-	0.15	-	0.45	
Styrene	$C_6H_5CH=CH_2$	100	420	250	1050	
Subtilisins (Proteolytic enzymes as 100% pure crystalline enzyme)		-	0.00006	-	0.00006	
Sucrose	$C_{12}H_{22}O_{11}$	-	10	-	20	
Sulfotep (ISO)	$(C_2H_5)_4P_2S_2O_5$	-	0.2	-	-	Sk
Sulphur dioxide	SO_2	2	5	5	13	
Sulphur hexafluoride	SF_6	1000	6000	1250	7500	
Sulphuric acid	H_2SO_4	-	1	-	-	
Sulphur monochloride	S_2Cl_2	-	-	1	6	
Sulphur pentachloride	S_2F_{10}	0.025	0.25	0.075	0.75	
Sulphur tetrafluoride	SF_4	0.1	0.4	0.3	1	
Sulphuryl difluoride	SO_2F_2	5	20	10	40	
2.4.5-T (ISO)	$C_8H_5Cl_3O_3$	-	10	-	20	
TDI		-	0.02	-	0.07	Sen
TEDP	$(C_2H_5)_4P_2S_2O_5$	-	0.2	-	-	Sk
TEPP (ISO)	$(C_2H_5)_4P_2O_7$	0.004	0.05	0.01	0.2	Sk
TNT	$CH_3C_6H_2(NO_2)_3$	-	0.5	-	-	Sk
Talc						
total inhalable dust		-	10	-	-	
respirable dust		-	1	-	-	
Tantalum	Ta	-	5	-	10	
Tellurium & compounds, except hydrogen telluride, (as Te)	Te	-	0.1	-	-	
Terphenyls, all isomers	$C_{18}H_{14}$	-	-	0.5	5	
1,1,2,2-Tetrabromo-ethane	$CHBr_2CHBr_2$	0.5	7	-	-	Sk
Tetrabromomethane	CBr_4	0.1	1.4	0.3	4	
Tetracarbonylnickel (as Ni)	$Ni(CO)_4$	-	-	0.1	0.24	
1,1,1,2-Tetrachloro-2,2-difluoroethane	CCl_3CClF_2	100	834	100	834	
1,1,2,2-Tetrachloro 1,2-difluoroethane	CCl_2FCCl_2F	100	834	100	834	

Tertrachloroethylene	$CCl=CCl_2$	50	335	150	1000	
Tetrachloromethane	CCl_4	2	12.6	-	-	Sk
Tetrachloronaphthalenes, all isomers	$C_{10}H_4Cl_4$	-	2	-	4	
O,O,O',O'-Tetraethyl dithiopyrophosphate	$(C_2H_5)_4P_2S_2O_5$	-	0.2	-	-	Sk
O,O,O',O'-Tetraethyl pyrophosphate	$(C_2H_5)_4P_2O_7$	0.004	0.05	0.01	0.2	Sk
Tetraethyl orthosilicate	$Si(OC_2H_5)_4$	10	85	30	255	
Tetrafluorodichloroethane	$CClF_2CClF_2$	1000	7000	1250	8750	
Tetrahydrofuran	$(C_2H_4)_2O$	200	590	250	735	
Tetramethyl orthosilicate	$(CH_3O)_4Si$	1	6	5	30	
Tetramethyl succinonitrile	$C_8H_{12}N_2$	0.5	3	2	9	Sk
Tetrasodium pyrophosphate	$Na_4P_2O_7$	-	5	-	-	
Tetryl	$(NO_2)_3C_6H_2N(NO_2)CH_3$	-	1.5	-	3	Sk
Thallium, soluble compounds (as Ti)	Tl	-	0.1	-	-	Sk
4,4'-Thiobis(6-tert-butyl-m-cresol)	$C_{22}H_{30}O_2S$	-	10	-	20	
Thioglycollic acid	$C_2H_4O_2S$	1	5	-	-	
Thionyl chloride	$SOCl_2$	-	-	1	5	
Thiram (ISO)	$(CH_3)_2NCS_2CS_2N(CH_3)_2$	-	5	-	10	
Tin, compounds, inorganic, except SnH4, (as Sn)	Sn	-	2	-	4	
Tin compounds, organic, except Cyhexatin (ISO), (as Sn)	Sn	-	0.1	-	0.2	Sk
Titanium dioxide	TiO_2					
total inhalable dust		-	10	-	-	
respirable dust		-	5	-	-	
Toluene	$C_6H_5CH_3$	50	188	150	560	Sk
Toluene diisocyanate (TDI)		-	0.2	-	0.07	Sen
p-Toluenesulphonyl chloride	$CH_3C_6H_4SO_2Cl$	-	-	-	5	
1,4,7-Tri-(aza)-heptane	$(NH_2CH_2CH_2)_2OH$	1	4	-	-	Sk
Tribromomethane	$CHBr_3$	0.5	5	-	-	Sk
Tributyl phosphate, all isomers	$(C_4H_9)_3PO_4$	-	5	-	5	
Tricarbonyl (eta-cyclopentadienyl) manganese (as Mn)	(C_5H_5)-$Mn(CO)_3$	-	0.1	-	0.3	Sk
Tricarbonyl (methylcyclopentadienyl) manganese (as Mn)	$(CH_3)C_5H_4$ -$Mn(CO_3)$	-	0.2	-	0.6	Sk
Trichloroacetic acid	CCl_3COOH	1	5	-	-	
1,2,4-Trichlorobenzene	$C_6H_3Cl_3$	5	40	5	40	
1,1,1-Trichlorobis (chlorophenyl) ethane	$C_{14}H_9Cl_5$	-	1	-	3	
1,1,2-Trichloroethane	$CH_2ClCHCl_2$	10	45	20	90	Sk
Trichlorofluoromethane	CCl_3F	1000	5600	1250	7000	
Trichloromethane	$CHCl_3$	2	9.8	-	-	
Trichloronitromethane	CCl_3NO_2	0.1	0.7	0.3	2	
2,4,5-Trichlorophenoxyacetic acid	$C_8H_5Cl_3O_3$	-	10	-	20	
1,2,3-Trichloropropane	$CH_2ClCHClCH_2Cl$	50	300	75	450	
1,1,2-Trichlorotrifluoroethane	CCl_2FCClF_2	1000	7600	1250	9500	
Tri-o-cresyl phosphate	$(CH_3C_6H_4O)_3P=O$	-	0.1	-	0.3	
Tricyclohexyltin hydroxide	$(C_6H_{11})_3SnOH$	-	5	-	10	
Tridymite, respirable dust	SiO_2	-	0.4	-	-	
Triethylamine	$(C_2H_5)_3N$	10	40	15	60	
Trifluorobromo-methane	CF_3Br	1000	6100	1200	7300	
Trimanganese tetraoxide	Mn_3O_4	-	1	-	-	
Trimellitic anhydride	$C_9H_4O_5$	-	0.04	-	-	Sen
Trimethylamine	$(CH_3)_3N$	10	24	15	36	
Trimethylbenzenes, all isomers or mixtures	$C_6H_3(CH_3)_3$	25	123	-	-	
3,5,5-Trimethyl-cyclohex-2-enone	$C_9H_{14}O$	-	-	5	25	
Trimethyl phosphite	$(CH_3O)_3P$	2	10	-	-	
2,4,6-Trinitrophenol	$HOC_6H_2(NO_2)_3$	-	0.1	-	0.3	Sk
2,4,6-Trinitrotoluene	$CH_3C_6H_2(NO_2)_3$	-	0.5	-	-	Sk
Triphenyl phosphate	$(C_6H_5)_3PO_4$	-	3	-	6	
Tripoli, respirable dust	SiO_2	-	0.4	-	-	
Tri-o-tolyl phosphate	$(CH_3C_6H_4O)_3P=O$	-	0.1	-	0.3	
Tungsten & compounds (as W).	W					
soluble		-	1	-	3	
insoluble		-	5	-	10	
Turpentine	$\sim C_{10}H_{16}$	100	560	150	840	

Substance	Formula	TWA OEL-RL		SHORT TERM OEL-RL		1995
		ppm	mg/m^3	ppm	mg/m^3	Notes
Uranium compounds, natural,	U					

soluble (as U)		-	0.2	-	0.6	
Vanadium pentoxide	V_2O_5					
total inhalable dust		-	0.5	-	-	
fume and respirable dust		-	0.05	-	-	
Vinyl acetate	$CH_3COOCH=CH_2$	10	30	20	60	
Vinyl benzene	$C_6H_5CH=CH_2$	100	420	250	1050	
Vinyl bromide	$CH_2=CHBr$	5	20	-	-	
4-Vinylcyclohexene dioxide	$C_8H_{12}O_2$	10	60	-	-	
Vinyl toluenes, all isomers	$C_6H_5C(CH_3)=CH_2$	-	-	100	480	
Warfarin (ISO)	$C_{19}H_{16}O_4$	-	0.1	-	0.3	
White spirit		100	575	125	720	
Xylene,o-,m-,p- or mixed isomers	$C_6H_4(CH_3)_2$	100	435	150	650	Sk
Xylidine, all isomers	$(CH_3)_2C_6H_3NH_2$	2	10	10	50	Sk
Yttrium	Y	-	1	-	3	
Zinc chloride, fume	$ZnCl_2$	-	1	-	2	
Zinc distearate	$Zn(C_{18}H_{35}O_2)_2$					
total inhalable dust		-	10	-	20	
respirable dust		-	5	-	-	
Zinc oxide, fume	ZnO	-	5	-	10	
Zirconium compounds (as Zr)	Zr	-	5	-	10	

Abbreviations

1. OEL - CL Occupational Exposure Limit - Control Limit.
   OEL - RL Occupational Exposure Limit - Recommended Limit.
2. ppm Parts per million.
3. mg/m^3 Milligrams per cubic meter.
4. SK Skin absorption.
5. Sen Capable of causing respiratory sensitisation.
6. ISO International Standards Organisation.

Note

(a) The concentration of “respirable dust” shall be determined from the fraction passing a size selector with an efficiency that will allow—
   (i) 100 % particles of 1 µm aerodynamic diameter,
   (ii) 50 % particles of 5 µm aerodynamic diameter,
   (iii) 20 % particles of 6 µm aerodynamic diameter,
   (iv) 0 % of particles of 7 µm aerodynamic diameter and larger to pass through the size selector.

(b) For asphyxiant substances, see Annexure 5.

TABLE 3
BIOLOGICAL EXPOSURE INDICES (BEI)

			1995
CHEMICAL DETERMINANT	SAMPLING TIME	BEI	Notation
ANILINE			
Total p-aminophenol in urine	End of shift	50 mg/g creatinine	C
Methemoglobin in blood	During or end of shift	1,5% of hemoglobin	B,C,D
ARSENIC AND SOLUBLE COMPOUNDS INCLUDING ARSINE			
Inorganic arsenic metabolites in urine	End of workweek	50 µg/g creatinine	B
BENZENE			
Total phenol in urine	End of shift	50 mg/g creatinine	B,C
Benzene in exhaled air:	Prior to next shift		
mixed-exhaled		0,08 ppm	D
end-exhaled		0,12 ppm	D
CADMIUM			
Cadmium in urine	Not critical	10 µg/g creatinine	B
Cadmium in blood	Not critical	10 µg/l	B
CARBON DISULFIDE			
2-Thiothiazolidine-4-carboxylic acid in urine	End of shift	5 mg/g creatinine	-
CARBON MONOXIDE			
Carboxyhemaglobin in blood	End of shift	less than 8% of hemoglobin	B,C

Carbon monoxide in end-exhaled air	End of shift	less than 40 ppm	B,C
CHLOROBENZENE			
Total 4-chlorocatechol in urine	End of shift	150 mg/g creatinine	C
Total p-clorophenol in urine	End of shift	25 mg/g creatinine	C
CHROMIUM (VI),			
Water soluble fume	Increase during shift	10 µg/g creatinine	B
Total chromium in urine	End of shift at end of workweek	30 µg/g creatinine	B
N,N-DIMETHYLFORMAMIDE (DMF)			
N-Methylformamide in urine	End of shift	40 mg/g creatinine	B
ETHYL BENZENE			
Mandelic acid in urine	End of shift at end of workweek	1,5 g/g creatinine	A
Ethyl benzene in end-exhaled air			D
FLUORIDES			
Fluorides in urine	Prior to shift	3 mg/g creatinine	B,C
	End of shift	10 mg/g creatinine	B,C
FURFURAL			
Total furoic acid in urine	End of shift	200 mg/g creatinine	B,C
n-HEXANE			
2,5-Hexanedione in urine	End of shift	5 mg/g creatinine	C
n-Hexane in end-exhaled air			D
MERCURY			
Total inorganic mercury in urine	Prior to shift	35 µg/g creatinine	B
Total inorganic mercury in blood	End of shift at end of workweek	15 µg/l	B
METHEMOGLOBIN INDUCERS			
Methemoglobin in blood	During or end of shift	1,5% of hemoglobin	B,C,D
METHANOL			
Methanol in urine	End of shift	15 mg/l	B,C
Formic acid in urine	Before shift at end of workweek	80 mg/g creatinine	B,C
METHYL CHLOROFORM			
Methyl chloroform in end-exhaled air	Prior to the last shift of workweek	40 ppm	
Trichloroacetic acid in urine	End of workweek	10 mg/l	C,D
Total trichloroethanol in urine	End of shift at end of workweek	30 mg/l	C,D
Total trichloroethanol in blood	End of shift at end of workweek	1 mg/l	C
METHYL ETHYLKETONE			
MEK in urine	End of shift	2 mg/l	-
METHYL ISOBUTYL KETONE			
MIBK in urine	End of shift	2 mg/l	-
NITROBENZENE			
Total p-nitrophenol in urine	End of shift at end of workweek	5 mg/g creatinine	C
Methemoglobin in urine	End of shift	1,5% of hemoglobin	B,C,D
ORGANOPHOSPHORUS			
CHOLINESTERASE INHIBITORS			
Cholinesterase activity in red cells	Discretionary	70% of individual's baseline	B,C,D
PARATHION			
Total p-nitrophenol in urine	End of shift	0,5 mg/g creatinine	C,D
Cholinesterase activity in red cells	Discretionary	70% of individual's baseline	B,C,D
PENTACHLOROPHENOL			
Total PCP in urine	Prior to the last shift of workweek	2 mg/g creatinine	B
Free PCP in plasma	End of shift	5 mg/l	B
PERCHLOROETHYLENE			
Perchloroethylene in end-exhaled air	Prior to the last shift of workweek	10 ppm	-
Perchloroethylene in blood	Prior to the last shift of workweek	1 mg/l	-
Trichlorocetic acid in urine	End of workweek	7 mg/l	C,D
PHENOL			
Total phenol in urine	End of shift	250 mg/g creatinine	B,C
STYRENE			
Mandelic acid in urine	End of shift	800 mg/g creatine	C
	Prior to next shift	300 mg/g creatinine	C
Phenylglyoxylic acid in urine	End of shift	240 mg/g creatinine	B,C
	Prior to next shift	100 mg/g creatinine	B,C
Styrene in venous blood	End of shift	0,55 mg/l	D
	Prior to next shift	0,02 mg/l	D
TOLUENE			
Hippuric acid in urine	End of shift	2,5 g/g creatinine	B,C
Toluene in venous blood	End of shift	1 mg/l	D
o-Cresol in urine	End of shift	1 mg/g creatine	C
TRICHLOROETHYLENE			
Trichloroacetic acid in urine	End of workweek	100 mg/g creatinine	C
Trichloroacetic acid and trichloroethanol in urine	End of shift at end of workweek	300 mg/g creatinine	C
Free trichloroethanol in blood	End of shift at end of workweek	4 mg/l	C
Trichloroethylene in end-exhaled air		D	
XYLENE			
Methylhippuric acid in urine	End of shift	1,5 g/g creatinine	-

	Last four hours of shift	2 mg/min	-

Notations

"A" notation: This notation indicates that an identifiable population group might have an increased susceptibility to the effect of the chemical, thus leaving it unprotected by the recommended BEI.

"B" notation This notation indicates that the determinant is usually present in a significant amount in biological specimens collected from subjects who have not been occupationally exposed. Such background levels are included in the BEI value.

"C" notation: This notation indicates that the determinant is non-specific, since it is observed after exposure to some other chemicals. These non-specific tests are preferred because they are easy to use and usually offer a better correlation with exposure than specific tests. In such instances, a BEI for a specific, less quantitative biological determinant is recommended as a confirmatory test.

"D" notation: This notation indicates that the biological determinant is an indicator of exposure to the chemical, but the quantitative interpretation of the measurement is ambiguous (semi-quantitative). These biological determinants should be used as a screening test if a quantitative test is not practical or a confirmatory test if the quantitative test is not specific and the origin of the determinant is in question.

Annexure 2:
CALCULATION OF EXPOSURE WITH REGARD TO THE SPECIFIED REFERENCE PERIODS

Calculation of exposure with regard to the specified reference periods

This Annexure reproduces the approved method for the calculation of exposure in relation to the 8-hour, short-term and one-year reference periods.

1. The 8-hour reference period

1.1 The term "*8-hour reference period*" relates to the procedure whereby the occupational exposures in any 24-hour period are treated as equivalent to a single uniform exposure for 8 hours.

1.2 The 8-hour TWA may be represented mathematically by:

$$\frac{C_1T_1 + C_2T_2 + .. + C_nT_n}{8}$$

where C_1 is the occupational exposure value (concentration) and T_1 is the associated exposure time in hours in any 24-hour period.

Examples

(*a*) The operator works for 7h20 min. on a process in which he is exposed to a substance hazardous to health. The average exposure during that period is measured as 0,12 mg m^{-3}.

The 8-hour TWA therefore is—

7h20 min (7,33h) at 0,12 mg m^{-3}.

40 min (0,67h) at 0 mg m^{-3}.

That is–

$$\frac{(0{,}12 \times 7{,}33) + (0 \times 0{,}67)}{8}$$

$$= 0{,}11 \text{ mg m}^{-3}$$

(*b*) The operator works for eight hours on a process in which he is exposed to a substance hazardous to health. The average exposure during that period is measured as 0,15 mg m^{-3}.

The 8-hour TWA therefore is–

$$\frac{0{,}15 \times 8}{8} = 0{,}15 \text{ mg m}^{-3}$$

(*c*) Working periods may be split into several sessions for the purpose of sampling to take account of rest and meal breaks, etc.

This is illustrated by the following example:

Working period	*Exposure (mg m^{-3})*	*Duration of sampling (h)*
08:00-10:30	0,32	2,5
10:45-12:45	0,07	2
13:30-15:30	0,20	2
15:45-17:15	0,10	1,5

Exposure is assumed to be zero during the period 10:30 to 10:45, 12:45 to 13:30 and 15:30 to 15:45.

The 8-hour TWA therefore is—

$$\frac{(0,32\times 2,5)+(0,07\times 2)+(0,20\times 2)+(0,10\times 1,5)+(0\times 1,25)}{8}$$

$$=\frac{0,80+0,14+0,40+0,15+0}{8}$$

$$=0,19\ \text{mg m}^{-3}$$

(*d*) An operator works for eight hours during the night shift on a process in which he is intermittently exposed to a substance hazardous to health. The operator's work pattern during the working period should be known and the best available data relating to each period of exposure should be applied in calculating the 8-hour TWA. This data should be based on direct measurement, estimates based on data already available or reasonable assumptions.

Working period	*Task*	*Exposure(mg m^{-3})*
22:00 to 24:00	Helping in workshop	1,10 (known to be exposure of full-time group in workshop)
24:00 to 01:00	Cleaning elsewhere in factory	0 (assumed)
01:00 to 04:00	Working in canteen	0 (assumed)
04:00 to O6:00	Cleaning-up after breakdown in workshop	0,21 (assumed)

The 8-hour TWA therefore is—

$$\frac{(0,10\times 2)+(0,21\times 2)+(0\times 4)}{8}$$

$$=0,078\ \text{mg m}^{-3}$$

2. The short-term reference period

Exposure should be recorded as the average over the specified short-term reference period and should normally be determined by sampling over that period.

Example where the short-term reference period is 15 minutes.

(*a*) *Exposure period is less than 15 minutes*

The sampling result should be averaged over 15 minutes. For example, if a 5-minute sample produces a level of 600 ppm and is immediately followed by a period of zero exposure, then the 15-minute average exposure will be 200 ppm:

(*b*) *Exposure period is 15 minutes or longer*

Measurements should be taken over a 15-minute period and the result is the 15-minute average exposure. Measurements for periods greater than 15 minutes should not be used to calculate a 15-minute average exposure, but if the average exposure over the longer period exceeds the 15-minute exposure limit, then this limit must have been exceeded over some 15-minute period.

3. The one-year reference period for vinyl chloride

Exposure should be recorded as the time-weighted average of vinyl chloride in the atmosphere of a working area over a period of one year. At enclosed vinyl chloride polymerisation plants, continuous or permanent sequential sampling methods must be used. Where discontinuous measurements are made, the frequency of measurements and the number per year should be such that it is possible to state with a statistical confidence coefficient of at least 95% that the true mean annual concentration did not exceed the annual maximum exposure limit. Only periods of plant operation including, where necessary, maintenance time should be taken into account.

Annexure 3
METHODS OF MEASUREMENT AND CALCULATION FOR DETERMINING THE FIBRE CONCENTRATIONS OF MANMADE MINERAL FIBRE

1. The method must determine the exposure of employees by sampling in the breathing zone of the employee exposed.

2. *Fibre* means a particle with a length > 5 µm, an average diameter < 3 µm, and a ratio of length to diameter > 3 to 1, which can be seen using the system specified in paragraph 3.

3. Fibres shall be counted in accordance with AIA RTM 1.

4. The results shall be regularly tested by quality assurance procedures to ensure that the results are in satisfactory agreement with the average of results, obtained by approved inspection authorities (AIA) participating in a national quality assurance scheme, using the method specified in paragraphs 1 to 3 above.

Annexure 4:
COTTON DUST

1. The OEL for cotton dust is 0,5 mg m^{-3} total dust less fly, 8-hour TWA. This figure is not a personal exposure limit but a background air standard determined by using static samplers. This OEL-RL applies to dust from the processing and handling of raw and waste cotton, including blends containing raw or waste cotton, with the following exceptions:

(*a*) Dust from weaving, knitting, braiding and subsequent processes; and

(*b*) dust from bleached or dyed cotton.

2. Under the HCS Regulations, assessors must satisfy themselves that the assessment takes account of people who work intensively with the material e.g. at bale opening, waste handling, maintenance of dust extraction equipment and cleaning procedures, and who are therefore likely to be exposed to dust.

3. Where the OEL-RL does not apply, exposure should be kept below both 10 mg m^{-3} 8-hour TWA *total inhalable dust* and 5 mg m^{-3} 8-hour TWA *respirable dust,* determined by a personal sampling method.

Annexure 5:
ASPHYXIANTS

1. Some gases and vapours, when present at high concentration in air, act as simple asphyxiants by reducing the oxygen content by dilution to such an extent that life cannot be supported. Many asphyxiants are odourless, colourless and not readily detectable. Monitoring the oxygen content of the air is often the best means of ensuring safety. The oxygen content of air in the workplace should never be allowed to fall below a minimum of 18% by volume under normal atmospheric pressure. Particular care is necessary when dense asphyxiants, e.g. argon, are used, since very high localised concentrations can arise owing to their collecting in pits, confined spaces and other low-lying areas where ventilation is likely to be poor.

2. Many asphyxiants present a fire or explosion risk. The concentration at hich these risks can arise are liable to be well below those levels at which asphyxiation is likely to occur and should be taken into account when assessing the hazards.

3. Although asphyxiants are listed in Table 2 of Annexure 1, they are not substances hazardous to health for the purpose of the HCS Regulations.

Annexure 6:
RUBBER FUME AND RUBBER PROCESS DUST

1. Rubber fume is fume evolved in the mixing, milling and blending of natural rubber or synthetic elastomers, or of natural rubber and synthetic polymers combined with chemicals, and in the processes which convert the resultant blends into finished products or parts thereof, and including any inspection procedures where fume continues to be evolved.

2. The limit relates to cyclohexane soluble material determined by the method described in *Rubber fume in air, measured as total particulates* and *cyclohexane soluble material.*

3. Rubber process dust is evolved during the manufacture of intermediates or articles from natural rubber and/or synthetic elastomers. This definition does not include dusts which, for occupational purposes, can be dealt with individually. In each case the relavent OEL will apply. Otherwise, where a substance with an OEL is present in a mixed dust, the OEL for that substance will apply, in addition to the rubber process dust limit.

4. Methods for personal sampling and measurement of total inhalable dusts are available in *General method for the gravimetric determination of respirable and total inhalable dust and Rubber fume in air measures as total particulates and cyclohexane soluble material.*

Annexure 7:
THE DEFINITION OF GRAIN DUST

1. *Grain dust* is taken to be dust arising from the harvesting, drying, handling, storage or processing of barley, wheat, oats, maize and rye, including contaminants.

Acknowledgement to HER BRITANNIC MAJESTY'S STATIONERY OFFICE

The Department of Labour hereby acknowledges the permission given by the Controller of HER BRITANNIC MAJESTY'S STATIONERY OFFICE (HMSO) for the reproduction of the Crown Copyright material listed below, or part thereof.

The conditions under which this permission was granted, are subject to the following:

- The source of the material must be acknowledged; and
- it must be mentioned that permission for the reproduction of such material was given by the Controller of HMSO.

LIST OF MATERIAL

1. Guidance note S20
2. HS(G)61
3. MDHS 14
4. MDHS 47
5. INDG(G)64-L
6. COSSH assessments
7. Pesticides: Code of Practice
8. EH14
9. EH22
10. EH23
11. EH25

12. EH28
13. EH40
14. EH42
15. EH44
16. EH56

Annexure 8:
MATERIAL SAFETY DATA SHEET

MATERIAL SAFETY DATA SHEET	No: Date issued: Page of
COMPANY DETAILS	
Name:	Emergency telephone no.:
Address:	Telex:
Tel:	Fax:
1. Product and Company Identification: **(Page 1 may be used as an emergency safety data sheet)**	
Trade name:	Chemical abstract no.:
Chemical family:	NIOSH no.:
Chemical name:	Hazchem code:
Synonyms:	UN no.:
2. Composition:	
Hazardous components: EEC classification: R Phrases:	
3. Hazards Identification:	
Main hazard: Flammability: Chemical hazard: Biological hazard: Reproductive hazard: Eye effects: eyes Health effects – skin: Health effects – ingestion: Health effects – inhalation: Carcinogenicity: Mutagenicity: Neurotoxicity:	
4. First-aid Measures:	
Product in eye: Product on skin: Product ingested: Product inhaled:	

5. Fire-fighting Measures:
Extinguishing media: Special hazards: Protective clothing:
6. Accidental Release Measures:
Personal precautions: Environmental precautions: Small spills: Large spills:
7. Handling and Storage:
Suitable material: Handling/storage precautions:
8. Exposure Controls/Personal Protection:
Occupational exposure limits: Engineering control measures: Personal protection – respiratory: Personal protection – hand: Personal protection – eye: Personal protection – skin: Other protection:
9. Physical and Chemical Properties:
Appearance: Odour: pH: Boiling point: Melting point: Flash point: Flammability: Autoflammability: Explosive properties: Oxidizing properties: Vapour pressure: Density: Solubility – water: Solubility – solvent: Solubility – coefficient: Neurotoxicity:
10. Stability and Reactivity:
Conditions to avoid: Incompatible materials: Hazardous decomposition products:
11. Toxicological Information:
Acute toxicity: Skin and eye contact:

Chronic toxicity:
Carcinogenicity:
Mutagenicity:
Neurotoxicity:
Reproductive hazards:

12. Ecological Information:

Aquatic toxicity – fish:
Aquatic toxicity – daphnia:
Aquatic toxicity – algae:
Biodegradability:
Bio-accumulation:
Mobility:
German wgk:

13. Disposal Considerations:

Disposal methods:
Disposal of packaging:

14. Transport Information:

UN no.
Substance identity no.
ADR/RID class:
ADR/RID item no.
ADR/RID hazard identity no.:
IMDG – shipping name:
IMDG – class:
IMDG – packaging group:
IMDG – marine pollutant:
IMDG – EMS no.:
IMDG – MFAG tabel no.:
IATA – shipping name:
IATA – class:
IATA – subsidiary risk(s):
ADNR – class:
UK – description:
UK – emergency action class:
UK – classification:
Tremcard no.:

15. Regulatory Information:

EEC hazard classification:
Risk phases:
Safety phases:
National legislation:

16. Other information: