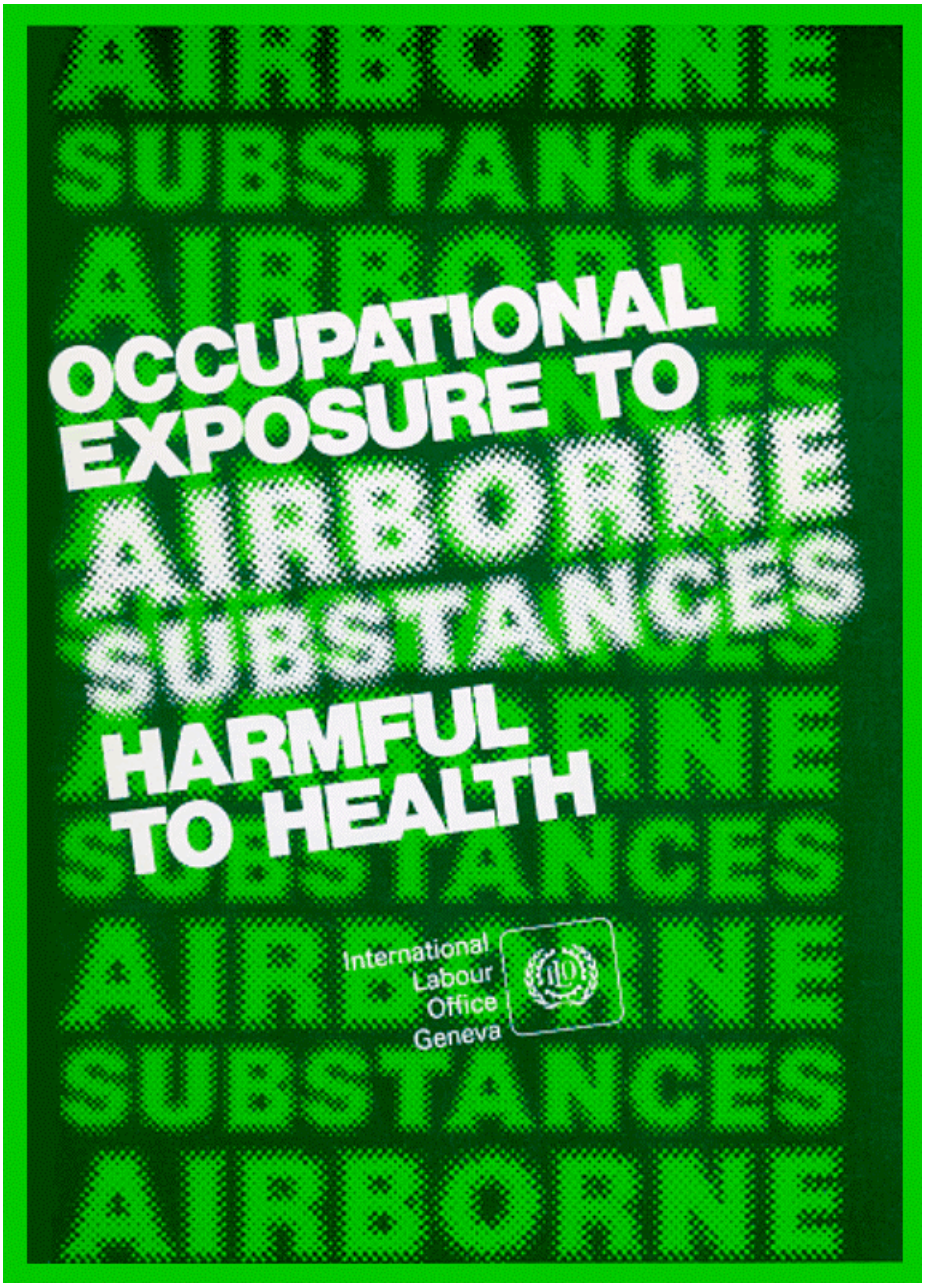
AIRBORNE SUBSTANCES
OCCUPATIONAL EXPOSURE TO AIRBORNE SUBSTANCES HARMFUL TO HEALTH
International Labour Office Geneva

The International Programme for the Improvement of Working Conditions and Environment (PIACT) was launched by the International Labour Organisation in 1976 at the request of the International Labour Conference and after extensive consultations with member States.

PIACT is designed to promote or support action by member States to set and attain definite objectives aiming at "making work more human". The Programme is thus concerned with improving the quality of working life in all its aspects: for example, the prevention of occupational accidents and diseases, a wider application of the principles of ergonomics, the improvement of the content and organisation of work and of conditions of work in general, a greater concern for the human element in the transfer of technology. To achieve these aims, PIACT makes use of and co-ordinates the traditional means of ILO action, including:

- the preparation and revision of international labour standards;
- tripartite meetings between representatives of governments, employers and workers, including industrial committees to study the problems facing major industries, regional meetings and meetings of experts;
- action-oriented studies and research;
- clearing-house activities, especially through the International Occupational Safety and Health Information Centre (CIS); and
- operational activities, including the despatch of multi-disciplinary teams to assist member States on request.

This publication is the outcome of a PIACT project.

Occupational exposure
to airborne substances harmful to health

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ILO Codes of Practice

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Preface

The present code is published in response to a resolution concerning the working environment adopted by the International Labour Conference at its 59th Session in June 1974. With the code of practice on the protection of workers against noise and vibration in the working environment, it complements the Working Environment (Air Pollution, Noise and Vibration) Convention (No. 148) and Recommendation (No. 156) adopted by the Conference at its 63rd Session in June 1977.

The code was approved by a Meeting of Experts on Limits of Exposure to Harmful Airborne Substances, organised in Geneva from 21 to 28 November 1977 by the International Labour Office with the participation of the World Health Organization.[1] Subsequently the Governing Body of the International Labour Office decided, at its 205th (February-March 1978) Session, to obtain more detailed comments on the code, and a small technical advisory group[2] was convened in January 1980 to draw up the final text of the code in the light of the comments received.

The Governing Body approved the publication of the code at its 2 12th (March 1980) Session.

The wording of the code is sufficiently flexible to permit its adaptation in the light of technological progress. The principles that it lays down are objectives which may be attained in successive stages in different countries and enterprises according to local circumstances and possibilities.

The code is not intended to be a substitute for existing national legislation, regulations or safety standards, but rather to provide guidance for governments, employers and workers. It is not compulsory in character, but has been drawn up in order to stimulate and guide those whose duty it is to promote, at the national level, the control of harmful airborne substances. It should be emphasised that enhanced payments to workers are no substitute for the introduction of the provisions set out in this code.

[1] See Appendix B for a full list of those attending the Meeting of Experts.

[2] The technical advisory group set up by the Governing Body was composed of Dr. A. Rothan, Chairman of the Meeting of Experts, Mr. S. J. Silk, Chairman and Reporter of the working party set up by the Meeting of Experts (see Appendix B), Mr. P. E. Arscott and Mr. J. P. Hamilton.

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1. General

1.1. Role of the bodies and persons concerned with the prevention of contamination of the working environment

1.1.1. The protection of workers' health against the hazards due to the contamination of air at the workplace and the prevention of contamination of the working environment should be the concern of all those involved in the design, organisation and performance of the work and all those concerned with the protection of workers' health.

1.2. Role of the competent authority

1.2.1. The competent authority, after consulting the employers' and workers' organisations concerned, should issue where necessary, and keep up to date, regulations on the prevention of contamination which are adapted to the particular branches of economic activity to which they apply.

1.2.2. The competent authority should have the expertise to supervise the enforcement of current regulations and exposure limits, where they exist, and to supply relevant information.

1.2.3. The regulations on the prevention of contamination should stipulate clearly all those persons responsible for carrying them out.[1]

1.2.4. The competent authority should bear in mind, when establishing regulations on the prevention of contamination of the working environment, the close links between the protection of the neighbourhood environment and that of the working environment.

1.2.5. The competent authority should determine the substances of which the manufacture, supply or use at the workplace should be prohibited or made subject to specific authorisation, which will require compliance with particular measures of prevention or protection.

1.2.6. (1) Special attention should be paid by the competent authority to the application of the regulations on the prevention of contamination of the working environment and to the provision of the technical advice which is often necessary in small and medium-sized undertakings.

[1] In so complex a field, the development of which is relatively recent, the administrative structure of a country may make it necessary to share out activities for the prevention of contamination; but it is of the greatest importance to ensure a clear distribution of responsibilities, and to prevent their dispersion, by assigning them to a single body which should maintain extensive relations with all the official services concerned.

(2) The competent authority should also provide for the extension of those regulations to home work which exposes workers to occupational health hazards.

1.2.7. (1) The inspectors responsible for the enforcement of the regulations should attach special importance to the development of co-operation between employers and workers on prevention matters.

(2) They should assist where possible in providing health and safety committees with the information they need to fulfil their responsibilities.

1.3. Role of employers

1.3.1. Employers are responsible for organising the prevention of contamination of the working environment; they should therefore equip and maintain buildings, installations, machines and workplaces and organise work in such a way that the working environment is not contaminated or at least that any contamination resulting from working operations is limited as far as is practicable and is within the exposure limits, where they exist, taking into account the provisions laid down in paragraph 2.2.17.

1.3.2. (1) The employer should stipulate that appropriate measures to prevent the contamination of the working environment should be borne in mind and provided for when buildings and installations are being designed and on the occasion of any technical change which may affect the quality of air at the workplace.

(2) Similarly, when purchasing equipment or process plant (machines, materials, vehicles), the employer should stipulate that such equipment or plant should comply with occupational hygiene standards or, where these do not exist, should be designed and safeguarded in such a manner as not to contaminate the working environment.

1.3.3. (1) The employer should investigate the health hazards of substances before their production or use so as to identify the preventive measures appropriate to such hazards; without such measures the substances should not be produced or used.

(2) Special precautions may be necessary during research operations.

(3) These provisions should also apply as far as practicable to intermediate products, by-products and wastes resulting from working operations or which could result from production incidents.

1.3.4. (1) The employer should supply or procure the equipment or services necessary for monitoring the working environment.

(2) All such equipment should be regularly maintained and calibrated.

1.3.5. The employer should ensure the surveillance necessary to enable workers to perform their tasks in the best possible hygienic conditions; in particular, provision should be made for the regular inspection and maintenance of installations and machinery liable to contaminate the working environment.

1.3.6. (1) The employer should ensure that all workers are suitably informed of the hazards associated with the tasks assigned to them and of the measures to be taken to prevent damage to their health. This information should also be transmitted, where appropriate, to subcontractors and their workers. In particular, provisions may be needed for newly recruited workers and for illiterate or foreign workers who may encounter language difficulties.

(2) For this purpose, the employer should ensure that his managerial staff are fully aware of their duties with regard to occupational hygiene and in particular that they are appropriately trained so that they may thoroughly instruct the workers regarding the precautions to be taken in their jobs and in the event of dangerous occurrences.

1.4. Role of workers

1.4.1. In order to protect their own health as well as that of their colleagues, workers should do everything in their power to prevent contamination of the working environment.

1.4.2. (1) Workers should abide by any instructions given to them in connection with the prevention of contamination of the working environment.

(2) Workers should submit themselves to medical surveillance where appropriate.

(3) Workers should wear personal samplers when necessary to measure personal exposure to contaminants.

(4) Workers should wear the personal protective equipment provided when other methods for the control of contamination are not feasible, for example in certain maintenance operations.

1.4.3. (1) When workers, through their job experience, have reason to believe that there would be a high risk to life or health if a task assigned to them were carried out, they should have the right to ask for a full investigation before commencing or, if appropriate, continuing work.

(2) Workers should immediately notify their employer, workers' representative and, if necessary, the competent authority of any such risk and of any defect which might lead to the contamination of the working environment.

1.4.4. Workers should inform the industrial physician or the plant service responsible for the application of the exposure limits of any changes in their state of health or of any subjective reactions in order to contribute to a better knowledge of the dose-effect relationship.

1.5. Role of occupational health officers

1.5.1. In addition to their specific activities, industrial hygienists, industrial physicians and nurses and safety engineers and technicians should devote an important part of their efforts to:

(a) information activities among workers and employers to alert them to the importance of protecting workers' health against the hazards caused by contamination of the working environment;
(b) applying their observations and the results of their inspections to epidemiological studies of the hazards of the working environment, the establishment or revision of exposure limits and the steady improvement of prevention criteria and methods; and
(c) the constant updating of their knowledge in this field.

1.6. Role of manufacturers and vendors

1.6.1. Manufacturers and vendors of equipment should ensure that machines, process plant, instruments and vehicles are designed and supplied to the user in such a manner and with such information that their operation and use contribute as little as possible to the contamination of the working environment and that they offer the least possible health hazard for workers during production operations and maintenance work.

1.6.2. Manufacturers and vendors of harmful substances should draw the attention of purchasers to the hazards associated with them and provide them with instructions concerning their safe use.

1.6.3. The occupational health standards followed in developing countries should be equivalent to those in developed countries, with regard to the construction and operation of plant and other industrial undertakings. This also applies to the buying, leasing and selling of machinery and other equipment.

1.7. Scientific research

1.7.1. In order that more effective prevention measures may be taken, scientific research institutions should strengthen their investigations into the effects of contaminants on the health and well-being of workers, giving particular attention to:

(a) any hazards associated with exposure to new substances;
(b) long-term hazards the source of which is more difficult to establish, such as carcinogenic and mutagenic effects;
(c) lesser known hazards, such as gonadotropic and teratogenic effects;
(d) hazards to which young persons are particularly sensitive; and
(e) the dose-response relationship.

In this connection, close collaboration should be established and maintained between scientific research institutions and occupational health officers.

1.7.2. Research should be undertaken with a view to replacing harmful substances or processes by harmless or less harmful substances or processes, wherever possible.

1.7.3. At the local level, employers' and workers' organisations may form working groups or consultative bodies to study local problems. At the national level, problems may be handled by bodies of a tripartite nature.

1.8. Co-operation

1.8.1. Where appropriate, there should be full co-operation at all levels between the competent authority, scientific research institutions, employers, workers and their representatives and occupational health officers.

1.8.2. The appropriate occupational health officers should be consulted at the design stage of new buildings and installations and before the introduction of any substantial technical change.

1.8.3. Joint employers' and workers' committees should be set up to give due attention to the prevention of health hazards. Any agreements reached in such committees may be included in the general conditions of employment.

1.8.4. (1) There should be regular consultations at plant level between the employer and the workers' representatives.

(2) These consultations should include frank and full exchanges of information on:

(a) the nature of the harmful substances to which workers are exposed and the risks which such exposure entails;
(b) the results of monitoring the working environment;
(c) the preventive action to be taken;
(d) the results of any epidemiological studies carried out, even in other countries, in similar working conditions;
(e) the results of plant inspections; and
(f) waste disposal.

(3) Although the responsibility of the employer as regards the organisation and implementation of preventive arrangements should in no way be minimised, his representatives should collaborate with the workers' representatives in order to:

(a) ensure the immediate application of the measures necessary to protect workers against the hazards of exposure to contaminants in the working environment, as soon as they have been identified; and
(b) contribute to prevention programmes and encourage all workers to participate in them, each in the role most appropriate to him.

1.8.5. Health and safety committees should endeavour to ensure the application of the regulations on the prevention of contamination and acquaint themselves regularly with the results of the monitoring of the working environment.

1.8.6. Occupational health officers should pay all due attention to the comments of workers regarding the subjective and objective effects of contamination of the working environment on their health and well-being.

1.8.7. In so far as is allowed by national practice, employers' and workers' representatives should be permitted to accompany inspectors when they are checking the application of the regulations concerning the prevention of contamination of the working environment.

2. Principles of the prevention of contamination of the working environment

2.1. Objectives

2.1.1. The ultimate aim of programmes for the prevention of contamination of the working environment is to eliminate contamination in order to protect the health of workers; and if that is not possible, the intermediate objective is to keep contamination at as low a level as possible by choosing the least harmful materials and products or by taking other technical measures to reduce the contamination of the working environment to the lowest possible level and at any rate to the exposure limit established by the competent authority or recommended by scientific bodies.

2.2. General preventive methods

2.2.1. (1) Whenever possible, harmful substances should be replaced by substances which offer the same technical advantages but which are harmless or less harmful.

(2) Experience suggests that all substitute materials should be subjected to thorough tests before use, to ensure that they do not introduce other unforeseen hazards and to determine their degree of safety.

2.2.2. (1) If no appropriate substitute materials exist, ideally a change in the process should be sought in order to achieve a satisfactory standard of safety.

(2) Processes involving a significant risk of exposure to very harmful substances (carcinogenic, radioactive, mutagenic, etc.) should be performed within an enclosed system so as to prevent any contact between the contaminant and persons through its release into the working environment, although the hazards may remain in some cases for maintenance and service personnel. In the event of an incident, special risks may arise.

(3) The direct handling of harmful substances should be avoided by the use of automatic processes where possible, or by remote control systems.

2.2.3. When work is carried out with dusty substances, wet methods should be used so far as possible.[1]

2.2.4. (1) So far as possible, operations likely to result in contamination of the working environment should be isolated from the remainder of the premises so as to reduce the number of persons exposed.

[1] Dust formation may be prevented by prior moistening of the substance, provided that the substance itself and its wastes are never allowed to dry.

(2) The area in which such operations are to be performed should be clearly marked out and indicated by appropriate warning signs.

2.2.5. In order to prevent or limit the release of potentially harmful substances, one of the following measures should be taken:

(a) containment within an appropriate enclosure;

(b) partial enclosure under negative pressure; or

(c) use of local exhaust ventilation situated as close as possible to the source of contamination, so that the contaminants can be captured before they reach the breathing zone of the worker.

2.2.6. Contaminants collected as outlined in the foregoing paragraph should be disposed of without risk to health.

2.2.7. The workroom should be provided with adequate ventilation.

2.2.8. Workrooms should be designed, built and maintained in such a manner as to:

(a) reduce as far as possible surfaces on which waste might accumulate;

(b) facilitate the cleaning of walls, floors, ceilings and machinery; and

(c) facilitate the collection and immediate neutralisation of any contaminants which escape in the event of an incident.

2.2.9. Wastes should be removed at intervals and by methods suitable for the type of hazard which they constitute (preferably by extraction or a wet system) in order to prevent the spread of contaminants.

2.2.10. (1) Employers should prepare clear and precise instructions for all working operations likely to release contaminants.

(2) Only duly authorised and adequately trained workers should participate in the most dangerous operations.

(3) A person authorised to take all necessary safety measures in the event of danger, including the stoppage of working operations, should be present or immediately available at all times in work areas.

2.2.11. (1) All containers which might release contaminants should bear a label indicating the nature of their contents and health hazards.

(2) The first-aid measures to be taken for these hazards should be detailed in notices displayed at the workplaces.

2.2.12. The competent authority may establish measures of prevention or protection applicable to the use of the most harmful substances, as noted in paragraph 1.2.5.

2.2.13. For work in confined spaces, special safety measures should be drawn up and applied.

2.2.14. The working environment should be monitored to ensure that the exposure levels of workers do not exceed the exposure limits.

2.2.15. When the concentrations of harmful substances in the workplace atmosphere cannot be brought within the exposure limits for the full working day or working week and where reduced working hours enable the exposure limits to be met, ceiling values and excursion limits should still be respected.

2.2.16. Workers exposed to contamination hazards should:

(a) maintain the greatest possible personal cleanliness;
(b) wear any work clothing provided; such clothing should be kept separate from ordinary clothing;
(c) wash their hands before entering the premises intended for the consumption of food and drink;
(d) avoid smoking; and
(e) take a shower before leaving the work premises, if this is recommended.

The employer should provide the facilities to make this possible.

2.2.17. (1) When exceptional circumstances make it necessary for a worker to enter an atmosphere contaminated by a harmful concentration of dusts, fibres, smokes, gases or irritating or toxic fumes or vapours, or radioactive aerosols, he should be made fully aware of these hazards and be provided with and wear appropriate respiratory protection and, if necessary, appropriate protective clothing.

(2) Gloves, aprons, goggles and other protective clothing made from suitable materials should also be available for the protection of workers exposed to the risk of contact with corrosive or radioactive substances and toxic dusts.

2.2.18. Workers should be informed of the inherent hazards of any contamination to which they are exposed, and the precautions necessary to prevent any harm to their health should be an essential part of any preventive programme. The competent authority and the employers' and workers' representatives should whenever possible co-operate in drawing up such programmes.

3. Exposure limits for harmful airborne substances

3.1. Establishment of exposure limits

3.1.1. The principle of exposure limits in the working environment should be established:

(a) by legislation; or
(b) by collective agreement or by any other agreements drawn up between the employers and workers; or
(c) by any other channel approved by the competent authority after consulting the employers' and workers' organisations.

3.1.2. When exposure limits have been established as in paragraph 3.1.1, the wording of the relevant provisions should be sufficiently flexible to permit updating as scientific knowledge, technology and socio-economic conditions progress.

3.1.3. The exposure limit system should be gradually extended to cover an increasing number of chemicals and physical agents, starting with:

(a) those involving the most serious hazards; and
(b) those to which the greatest number of workers are exposed.

3.1.4. (1) When the exposure limits are established, allowance should be made for:

(a) scientific knowledge with regard to all the hazards associated with exposure to the substances in question;
(b) the subjective reactions of the human body; and
(c) the monitoring possibilities.

(2) Exposure limits should in general be established or modified through consultation with the employers' and workers' organisations concerned.

3.1.5. Exposure limits should be based on a study of the dose-effect and dose-response relationship. They should be established in the light of the following data:

(a) the physical and chemical properties of the substance, including the nature and quantity of contaminants;
(b) the ways in which it is expected to use the substance, and features of the exposure of workers;
(c) the results of experiments with laboratory animals designed to establish:
    (i) the acute local and general effects (irritation and sensitisation);
    (ii) the effects of repeated administration; and
    (iii) the chronic general effects, including those affecting the central nervous system (mutagenic, carcinogenic, gonadotropic and teratogenic effects); and
(d) the results of:
    (i) routine medical examinations of exposed workers;

(ii) epidemiological investigations; and
(iii) case studies of occupational diseases.

3.1.6. The exposure limits should be constantly reviewed, with account being taken of any new knowledge concerning the hazards associated with exposure to the substance in question and particularly, as regards limits adopted in the light of experimental research, the results of the monitoring of the workers exposed.

3.1.7. (1) In view of the diversity and different biological effects of the substances, all scientific research methods should be applied in seeking a dose-effect and dose-response relationship for any harmful effect.

(2) In practice, preference should be given to the experimental methods which appear, after a preliminary study of the substance in question, to be most suitable.

3.1.8. In the case of newly produced substances, all available toxicological and occupational hygiene data should be provided to the competent authority before a decision is taken concerning their acceptability and, where appropriate, use.

3.1.9. When the results of experimental investigations are interpreted, account should be taken of the fact that the detection of the biological effects of a substance depends not only on the dose used but also on the following conditions:

(a) that the effect was foreseen when the experiment was designed;
(b) that a fairly sensitive method of analysis was used; and
(c) that the investigations were carried out with a species of animal likely to show the reaction in question.

3.1.10. (1) When data on the properties of the substances and the results of experimental studies, biological monitoring of workers, epidemiological studies and case studies are extrapolated to the exposure limits, a safety factor should always be incorporated in order to allow for the metabolic and functional differences between man and animals, the differences between experimental conditions and occupational exposure, and the selection made in the working population.

(2) This safety factor should be established for each substance by a group of experts, on the basis of scientific knowledge applicable to each case and in accordance with the health concept adopted by the national authority.

3.1.11. (1) When a country adopts exposure limits established in another country,[1] account should be taken of possible differences with regard to climate, altitude,

[1] Since the establishment of exposure limits implies research on a significant scale calling for the mobilisation of a considerable volume of special equipment and a large number of specialised personnel, only certain countries are able to carry out all the original work needed to cover a large number of substances. However, the value of expanding to the maximum the store of data for the establishment or revision of such values is obvious. Thus, any observations or research which could be used for this purpose, and which has been obtained by a correct methodological approach and the use of comparable techniques, should not remain a dead letter but should be made use of. Information or guidance can be obtained, if necessary, from competent international organisations such as the ILO or the World Health Organization.

pollution of the living and general environment, conditions of work and physical effort, eating habits and health of the population, anthropometric data, distribution of workers by age and sex, and the general level of protection against occupational hazards; these differences may affect the absorption, metabolism, elimination and biological effects of hazardous substances in the body's system.

(2) Where necessary, exposure limits should be corrected by the application of an appropriate safety factor.

3.1.12. Substances likely to be absorbed not only by inhalation but also through the skin should be identified, and it should be emphasised that the mere respect of exposure limits for these substances will not constitute protection if personal hygiene is inadequate.

3.1.13. Where substances with the greatest hazards are involved, efforts should be made to reduce exposure to the minimum possible level if it cannot be entirely eliminated.[1]

3.1.14. Special limits for short exposures which are higher than the normal exposure limits should not serve as a means of avoiding the need to keep contamination of the working environment as low as possible.

3.2. Application of exposure limits

3.2.1. Exposure limits should not be considered as relative toxicity criteria nor be used in non-occupational control of contamination, nor should they be applied to an exposure longer than the normal work period, nor be quoted to establish the existence or nonexistence of an occupational disease.

3.2.2. (1) In appropriate cases, the competent authority may give guidance on methods of monitoring the working environment, indicating the sampling frequency and methods to be applied for specific substances.

(2) So far as possible and especially as regards dusts, the methods and instruments used for monitoring the working environment should be the same as those used for establishing or revising the exposure limits. If different instruments are used, it is essential to correlate the results.

3.2.3. (1) The monitoring of concentrations of toxic airborne substances in the working environment should be performed only by skilled personnel with adequate equipment and technical training.

(2) Those responsible for occupational hygiene control should also have received special training in this field.

[1] The establishment of exposure limits for a carcinogenic substance raises many problems because of the very high risk associated with it, the long latent period between exposure to the carcinogenic substance and appearance of the disease, and the diversity in the carcinogenic effects of various substances.

3.2.4. An industrial physician, where employed, should visit workrooms frequently.[1]

3.2.5. (1) When an occupational hygiene survey is to be carried out, a preliminary visit to the workplace may be required in order to evaluate the exposure of workers and establish the techniques to be used in the investigation, especially the place and time at which samples are to be taken, and the types of analysis.

(2) The representative(s) of the workers assigned to the jobs in question, the supervisor and the industrial physician should all be associated with this survey.

3.2.6. All relevant data from measurements of concentrations of contaminants in the working environment should be systematically recorded as soon as possible; workers, or their representatives, should have access to these records.

3.2.7. (1) Where possible, the industrial physician should be actively associated with the interpretation of the results of the occupational hygiene survey.

(2) As the ultimate aim of the operation is the protection of workers' health, confidence should not be placed in any purely numerical estimate consisting merely of a verification of the concentration of harmful airborne substances in the working environment in relation to the exposure limits, because the data collected are valid only if allowance is made for the true exposure of workers (duration, conditions and nature of work, biological features and health of the group or the individual, etc.).

3.2.8. (1) In the event that monitoring of the working environment discloses levels in excess of the exposure limits, employers should explain to workers the causes of the excess and the action to be taken.

(2) The necessary technical, administrative or organisational preventive action should be taken as rapidly as possible in consultation with the workers' representatives.

3.2.9. The competent authority should where possible establish the action level.

3.2.10. If the measured values of the concentrations of harmful airborne substances in the working environment show during the first occupational hygiene survey that the exposure of workers does not exceed the action level, the preventive measures indicated in paragraphs 3.2.11 to 3.2.15 may be considered as unnecessary.

3.2.11. The competent authority may decide that, where there is an obligation for workers assigned to jobs involving specified hazards to undergo routine medical examinations, such provisions may not apply to workers whose present and past exposure does not exceed the action level.

[1] The fact that the technical monitoring of contamination of the working environment may be entrusted to a service other than that responsible for occupational health or to personnel who have not received medical training must not prevent the industrial physician from respecting his obligation to visit workplaces regularly, nor would it be a duplication of his work.

3.2.12. The periodical monitoring of a working environment presenting an exposure level below the action level may be carried out less frequently than specified in paragraph 3.2.2; the frequency of monitoring may be established by the competent authority or the body responsible for the application of workplace exposure limits.

3.2.13. Independently of the provisions of paragraphs 3.2.11 and 3.2.12 above, the relevant measures for the prevention of contamination indicated in this section should be applied even if the exposure level does not exceed the action level.

3.2.14. The concentration of harmful airborne substances in the working environment should be promptly monitored after every technical or other modification which could produce significant changes in the exposure of workers.

3.2.15. Neither the exposure limits nor the action levels should apply to confined spaces, where special precautions need to be taken.

3.3. Measurement and control of harmful airborne substances in the working environment

3.3.1. (1) In the case of toxic substances which have a cumulative effect (such as lead or quartz), as this effect depends on the over-all dose absorbed, variations may be accepted in the concentration of the toxic substance above and below the exposure limits, considered as time-weighted averages, provided that each upward variation is compensated by an equivalent variation below the exposure limits and that the excursions remain within permitted limits.

(2) On the other hand, in the case of substances such as formaldehyde, sodium hydroxide or ethyl acetate which, even after only a short exposure to concentrations above the exposure limit, can cause unbearable irritation, irreversible tissue damage or narcosis sufficiently pronounced to increase the accident hazard, only the ceiling limits should be adopted, and these should be strictly respected.

3.3.2. (1) Air samples should be collected in the worker's breathing zone whenever the purpose is to evaluate the health hazard. Personal samplers may conveniently be used for this purpose.

(2) In order to obtain indications of the distribution of contamination throughout the general atmosphere of the working area, samples should also be taken:

(a) as close as possible to pollutant sources, to indicate the standard of process control; and

(b) at various places in the working area.

3.3.3. The minimum volume of the air sample to be taken for each analysis should be determined according to the sensitivity of the analytical method.

3.3.4. (1) Sampling should always be carried out during working hours when the process is in operation.

(2) Where concentrations may vary from one work operation or phase to another, sampling should be done in such a manner as to be able to determine the average level and, in any case, the maximum exposure.

3.3.5. The sampling of substances for which time-weighted averages exist should take place throughout the work period and be supplemented, where necessary, by short-time sampling during periods of peak concentration, unless it is certain that the concentration remains constant.

3.3.6. Very short-term evaluations have only a screening value and should be repeated by more accurate methods in order to eliminate instrument error and the effects of excursions of the contamination under examination.

3.3.7. The sampling of substances for which a ceiling limit exists, or the measurement of the concentration of such substances in the working environment, should normally last 15 minutes.

3.3.8. In general, only analytical methods already applied successfully in occupational hygiene should be adopted for determining the concentrations of harmful airborne substances in the working environment.

3.3.9. In applying the exposure limits for dust, account should be taken not only of figrogenic dust but also of the accompanying inert/nuisance dust.

3.3.10. (1) The concentration of free silica in respirable airborne dust should be measured directly on the dust captured in the air and not on the original substances.

(2) Such analysis should be carried out on the total dust in addition to the respirable dust.

3.3.11. When the concentrations of harmful airborne substances in the working environment approach the exposure limits, it is recommended that data for the various seasons of the year be considered before drawing conclusions regarding the contamination level.

3.3.12. (1) When two or more harmful substances are airborne in the working environment, as is often the case, particularly close attention should be given to their combined effects.

(2) Where there is no proof to the contrary, the effects in question should always be considered as additive.

3.3.13. When the results are interpreted, it may be assumed that there can be errors of ± 50 per cent under stable conditions.

3.3.14. Under complex contamination conditions where the substance having the most serious effect (e.g. carcinogenic) has not been identified, workers cannot be protected by applying the exposure limits, so that it is necessary to adopt processes and technical measures ensuring minimum contamination and exposure and to apply

biological monitoring, rather than to concentrate all efforts on monitoring the working environment.

3.3.15. In other cases, where the main risk is that of an accidental release, it is necessary both to provide individual and technical protection for workers and to monitor the working environment.

4. Specific medical surveillance of workers exposed to harmful airborne substances

4.1. Medical surveillance[1]

4.1.1. The purpose of medical surveillance is the prevention of occupational diseases and their early detection and to contribute towards improving the working environment.

4.1.2. Medical surveillance includes specific medical examinations, biological monitoring and epidemiological surveillance.

4.2. Medical examinations

4.2.1. Any worker who may be exposed to hazards caused by contamination of the working environment should be informed of the health hazards to which he could be exposed by his work and the precautions to be taken. Where appropriate, he should be medically examined before he is engaged:

(a) to see whether he is medically fit for the job under consideration;
(b) to determine the jobs to which he should not be assigned from a medical point of view, and those which suit him best; and
(c) to establish for each worker a biological and health reference baseline.

4.2.2. The pre-employment medical examination should consist of a general clinical examination backed up, if necessary, by other more specific tests according to the occupational hazards involved.

4.2.3. This type of medical examination should be carried out each time that a change of job may involve a change in the nature of the hazard to which the worker is exposed.

4.2.4. Any worker exposed to serious occupational hazards or belonging to a special category (young persons, women of childbearing age, pregnant women, nursing mothers, handicapped persons, older workers) and exposed to hazards caused by contamination of the working environment should undergo periodic specific medical examinations to check whether he or she is still fit for work, to detect the earliest signs of possible injury to health as a result of his exposure, and to provide him or her with appropriate advice on hygiene and medical matters.

[1] Medical surveillance relates to effects—often delayed—and not to causes. It may provide valuable information on the application of technical prevention measures and the validity of exposure limits. However, this calls for the closest collaboration between occupational health officers and real support from employers and workers.

4.2.5. To the extent that the nature and degree of the hazard so require, periodic medical examinations should be as complete as possible and include, if necessary, other tests according to the occupational hazard involved.

4.2.6. Periodic medical examinations may vary in their frequency, depending on the nature of the hazard and the level of exposure noted at the workplace.

4.2.7. Workers should be subjected to particularly close surveillance during the first months of their assignment to jobs in which they are exposed to harmful substances, especially sensitising substances. Such surveillance should permit all the necessary measures to be taken when required.

4.2.8. Special medical surveillance should be available to workers who have been exposed in the past to occupational hazards, in particular carcinogenic substances or ionising radiation.

4.3. Biological monitoring

4.3.1. (1) Whenever valid biological monitoring methods[1] are available, they should be used to complement monitoring of the working environment in order to increase protection of workers' health.

(2) Under certain circumstances, such as work in the open, biological monitoring may be the most practical method in view of the difficulty of monitoring the working environment.

4.3.2. Biological monitoring complements monitoring of the working environment by assessing the absorption of harmful substances both in the individual and in the group, and by evaluating individual susceptibility.

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[1] Biological monitoring may provide the information necessary to prevent contamination of the working environment and to increase the knowledge required to protect the health of workers.

Through the measurement of the dose received (either directly, through the determination of the concentration of the harmful substance in an indicator tissue or fluid, or indirectly, through the determination of a metabolite of the harmful substance or of a reversible biochemical response), biological monitoring has become increasingly recognised as a valid method for the assessment of individual exposure.

With the development of more sensitive analytical biochemical methods, the number of harmful substances for which biological monitoring is possible has increased considerably in the past few years. However, against the multitude of harmful substances which may be present in the working environment, biological monitoring is minimal and further research efforts in this field are required.

An in-depth discussion of the advantages and disadvantages of monitoring the working environment and of the complementarity of monitoring the working environment, biological monitoring and medical examinations, is outside the scope of this code of practice (see WHO: *Early detection of health impairment in occupational exposure to health hazards: Report of a WHO study group,* Technical report series, No. 571 (Geneva, 1975)).

4.3.3. Biological monitoring requires the full co-operation of workers.[1] Workers should be fully informed by the appropriate authorities regarding the scope of biological monitoring and the significance of the results.

4.3.4. Whenever necessary and practicable, biological monitoring should be based not on one single parameter but on several parameters for each harmful substance.

4.3.5. Wherever possible, techniques of examination which do not harm the body in any way and carry no risk should be used.

4.3.6. The frequency of biological monitoring should depend on the magnitude and type of hazard, the biological half-life of the substance, the uptake curve and other variables in the environment and in the individual worker.

4.3.7. Trained personnel are required for both sampling and analysis. Adequate provision should be made for such training.

4.3.8. Adequate laboratory facilities should be provided. Depending on the type and the number of analyses required, they may be performed either on the work premises or in specialised laboratories. The validity of the results of biological monitoring should be ensured by calibration of equipment, standardisation of techniques and time of sampling, and replication of analyses.

4.4. Biological limits[2]

4.4.1. (1) Evaluation of the over-all hazard presented by the working environment should be based on the results from the group of workers exposed to a given level of the harmful substance, in order to offset the effect of individual biological variability.

(2) Any worker for whom the findings exceed the biological limits should undergo further and repeated biological and medical investigations.

4.5. Other provisions

4.5.1. The results of medical examinations and biological monitoring should be made available to the worker, and at his request to his personal physician.

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[1] As indicated in Paragraph 16(1) of international labour Recommendation No. 156, "The supervision of the health of workers ... should include, as determined by the competent authority . . . biological or other tests or investigations which may be necessary to control the degree of exposure and supervise the state of health of the worker concerned."

[2] For the purpose of evaluating the results of biological monitoring, biological limits have been proposed for the harmful substance itself and its metabolites, or for the effects of the substance or its metabolites on the body (e.g. on enzymes or their precursors). These limits vary according to the specimen examined (urine, blood, exhaled air).

Research is urgently required to establish dose-response and dose-effect relationships in order to obtain criteria for setting biological limits.

4.5.2. The medical surveillance provided for in the present chapter should normally be carried out in working hours and should be free of cost to the worker.

4.5.3. Provision should be made for the maintenance, for an appropriate period of time, of records of medical and biological examinations and of occupational exposure. These records should be available for prospective epidemiological and other research, in terms which will permit personal identification only by those authorised. The records should permit subsequent medical surveillance of workers after cessation of employment.

4.5.4. Where continued assignment to work involving exposure to atmospheric contamination is found to be medically inadvisable, every effort should be made, consistent with national practice and conditions, to provide the worker concerned with suitable alternative employment.

Appendices

A. Glossary

For the purposes of this code of practice, the following terms have the meanings shown:

Action level: a level of exposure of workers to airborne harmful substances in the working environment to be determined by the competent authority. It is distinctly below the exposure limits and consequently exposures below the action level do not usually necessitate application of all the preventive measures, for example those of a medical nature often required for exposures exceeding the action level. The action level will generally lie at or below half of the exposure limit.

Aerosol: an airborne suspension of solid or liquid particles.

Allergy: a qualitative and specific change in the body's sensitivity to a foreign substance; it implies the formation in the body of specific globulins (antibodies) against the causative substance (allergen).

Asphyxiating agent (physical or chemical): substance capable of causing breathing to stop by acting on the central nervous system (e.g. a narcotic); by replacing the oxygen of inhaled air (e.g. nitrogen, methane, carbon dioxide); or by preventing the fixation of oxygen by haemoglobin (e.g. carbon monoxide, aniline); or on the cell systems (e.g. hydrocyanic acid).

Carcinogen: substance or agent capable, even at low doses, of producing malignant conditions, usually several years after the onset of its action on the body; certain substances and agents have been shown to have a carcinogenic effect on man while many others must be considered suspect because they can cause cancers in animals, under experimental conditions using widely varying exposure frequencies, concentrations and time lapses.

Combined effects: effects of simultaneous exposure to multiple physical, chemical or infective agents in the working environment, as is usually the case in occupational exposure; these effects may be independent of each other, or represent the aggregate effect of the same agents when considered separately (additive effects); in rare cases, they may be either stronger than the additive effects (synergistic effects), or weaker than if they had been separate (antagonistic effects).

Competent authority: minister, official service or any other public authority having power to issue or approve decrees, orders, regulations or other provisions having the force of law, concerning the prevention of contamination of the working environment.

Confined space: space in which the presence of a worker may be justified in exceptional cases for building, repair or maintenance work, having a volume so restricted that even uniform dispersion of contaminants released in small quantities does not always prevent the formation of a hazardous concentration in the worker's breathing zone; special precautions have to be taken in confined spaces to prevent oxygen shortage and air contamination, even where the substances present are ones which would not be considered as harmful under normal space and ventilation conditions.

Contaminant: airborne solid, liquid, fume or gaseous matter, odour, micro-organisms or any combination of them, which may in certain concentrations or quantities impair the quality of the working environment and/or health.

Contamination: the airborne pollution of the working environment by a contaminant.

Cumulative effect: result of repeated exposure to a concentration of toxic substances, not necessarily with acute effects; the cumulative effect is due to the fact either that the amount excreted is less than that absorbed or that the biological effects of each exposure are additive.

Dose-effect relationship: the effect that a substance may have on the body (i.e. certain biological parameters) depending on the dose absorbed; it depends on the concentration of the substance in the air inhaled and on the duration of exposure, subject to the variability of the subject himself and local conditions.

Dose-response relationship: the effect that a substance may have on a group of individuals depending upon the dose absorbed; it is measured by the percentage of individuals showing an effect of a given nature and intensity. These relationships may be:

(a) *linear* when the response is directly proportional to the dose;
(b) *non-linear* when the response is not directly proportional to the dose; or
(c) *all or nothing* when a dose threshold has to be reached to produce a response.

Dust: airborne solid particulate matter, the particle size being greater than that of a fume; dusts are usually produced by the mechanical erosion of a solid; they can have various biological effects (e.g. fibrogenic, toxic or a mixture of these); the concentration of an airborne dust is expressed as a weight (mg/in^3) or as a number (number of particles/cm^3), but for results to be comparable it is necessary to know the range of particle size:

(a) *fibrogenic dust:* mineral dust capable of causing an increase in the connective tissue of the lung with permanent alteration of the lung structure; this increase may be nodular or irregular; the most common types are free crystalline silica (quartz and its allotropic varieties, i.e. tridymite and cristobalite, which are more dangerous than quartz itself) and asbestos;
(b) *inert/nuisance dust:* dust which is neither toxic nor fibrogenic; it may collect in the lung without modifying its structure, but when inhaled in large quantities it can impede the functioning of the respiratory system;
(c) *respirable dust:* that fraction of the total dust which passes through a selector having specific characteristics approaching those of the human respiratory tract;[1]
(d) *total dust:* all the airborne dust (i.e. without size selection) which is collected during sampling; and
(e) *toxic dust:* dust other than fibrogenic dust usually composed of soluble or partly soluble compounds capable of having acute or chronic harmful effects on specific organs including and beyond the respiratory tract.

[1] The definition of respirable dust varies in member States. Some of them follow the definition adopted by the Johannesburg Convention of 1959 and later by the British Medical Research Council; others follow the current definition of the American Conference of Governmental Industrial Hygienists. In some member States the definition varies according to the nature of the dust.

Johannesburg Convention (1959)	
Aerodynamic diameter (pm) (unit density sphere)	% passing selector
2.0	98
2.5	88
3.5	76
5.0	50
7.1	0

ACGIH (1979)	
Aerodynamic diameter (pm) (unit density sphere)	% passing selector
2.0	90
2.5	75
3.5	50
5.0	25
10.0	0

Epidemiological study: study of the effects of various factors, including the individual's constitution, occupational exposure, the psycho-social climate and the environment, on the aetiology, distribution, incidence and prevalence of a disease or any other specific biological or social phenomenon.

Exposure limit to airborne harmful substances at the workplace:[1] concentration in the air of a harmful substance which does not, it is believed in the light of present scientific knowledge, cause adverse health effects—including long-term effects and effects on future generations—in workers exposed for eight to ten hours per day and 40 hours per week; such exposure is considered acceptable by the competent authority which establishes the values, although concentrations below the exposure limit may not completely guarantee protection of the health of all workers; the exposure limit therefore does not constitute an absolute dividing line between harmless and harmful concentrations but merely serves as a guide for the prevention of hazards;

Exposure limit: other relevant terms:

(a) *ceiling:* indicates a concentration in respiratory air which must not be exceeded at any time;

(b) *permitted excursion:* amount of excursion beyond the time-weighted average which is considered permissible by the competent authority or the body responsible for exposure limits;

(c) *short-term exposure:* indicates the highest concentration to which workers may be exposed for up to 15 minutes without suffering unbearable irritation, chronic or irreversible damage to tissues, or narcosis sufficiently pronounced to cause a risk of accidents, reduce their ability to escape in the case of need, or diminish their working efficiency, provided that they are not exposed more than a specified number of times during a day and without a specified minimum interval between two successive exposures, and provided that the average daily exposure does not exceed the time-weighted average exposure limit; and

(d) *time-weighted average:* average time-weighted concentration which may be adopted as the exposure limit for substances whose effects are cumulative or for which there is a fairly wide safety margin between concentrations which are harmful and those which are not, provided that the exposure limit for the permitted excursions is not exceeded.

Fume: aerosol of a finely divided solid, consisting of particles of less than 1μm in diameter, generally formed either by combustion in the air, which causes solid particles to be airborne (metallic oxides, ashes, soot), or by the condensation of a vapour.

Gas: state of matter characterised by the absence of specific shape and a variable volume resulting from its expansibility or compressibility; the concentration of a gas or vapour in the air is expressed either as a volume (parts per million parts of air (ppm or cm^3/m^3)) or by weight (milligrams per cubic metre of air (mg/m^3)) at a temperature of 25^0C and a pressure of 760 mmHg; one form of expression can be converted to the other, at standard temperature and a pressure of 760 mmHg, using the following formulae:

[1] Convention No. 148 and Recommendation No. 159, adopted by the International Labour Conference in 1977, use the general expression "exposure limit". This term replaces the old terms "maximum allowable concentration", "permissible limit", "threshold limit value", etc., without going into detail regarding ceiling or weighted averages. There are indeed reasons for dropping the earlier wordings as they seem to imply an administrative or legal approval which does not always exist, or to relate to a biological evaluation which is not applicable generally to all workers.

value in ppm x molar mass/24.45 = value in mg/m^3;

value in mg/m^3 x 24.45/molar mass = value in ppm.[1]

The higher the concentration of a gas or vapour in the air and its solubility in the blood and living tissues, the greater is the bodily absorption.

Gonadotrope: a substance or agent capable of adversely affecting the sexual glands.

Harmful substance: substance or mixture of substances capable of harming workers' health or safety during employment, after employment or in later generations.

Hazard: probability of impairment to health following exposure to a specific substance; the level of the hazard depends not only on the toxicity of the substance itself but also on the use and the absorption rate.

Health: state of complete physical, mental and social well-being, and not merely an absence of disease or disablement.

Ingestion: entry of a toxic or other substance into the body through the digestive tract; if elementary principles of personal hygiene are applied, this can occur at workplaces only rarely and accidentally.

Inhalation: entry of a substance into the body through the respiratory tract. This is the main path of entry of toxic substances into the body; having reached the lung, the substances may remain stored in the lung tissue or nodes (insoluble dusts) or pass into the blood (gases and vapours, fumes, soluble dusts) through the alveolar surface and reach the upper nerve centres without undergoing any filtration; as the alveolar surface is about eight times larger than the digestive surface and 40 times greater than the skin, absorption is much faster and constitutes a greater hazard than entry by other routes.

Irritant: a substance, generally in the form of gas, aerosol or dust, or agent able to cause inflammatory reactions of the respiratory tract, conjunctive tissues or skin; highly soluble gases and vapours, such as ammonia, act mainly on the upper respiratory tract; on the other hand, less soluble gases and vapours, such as nitrogen dioxide, penetrate more deeply into the respiratory tract and are more dangerous because of the associated risk of pulmonary oedema.

Mist: aerosol consisting of droplets (e.g. oils or acids).

Monitoring: systematic surveillance of the hazards to which workers are exposed; it may be carried out by measuring certain parameters of the working environment, particularly the concentrations of airborne toxic substances, or by measuring biological parameters, particularly the concentrations of toxic substances or their metabolites or certain organic reactions in the urine, blood or exhaled air.

Mutagen: substance or agent capable of causing sudden and lasting changes in one or more hereditary features, generally by modifying one or more genes; if these changes take place only in somatic cells (e.g. the blood cells), they are not transmitted to descendants.

Occupational health officer: a specialist in the problems associated with the protection of workers' health against occupational hazards, who acts as adviser to employers and workers; he

[1] For different temperatures and/or pressures, the formula must be adapted. For an ambient temperature of 20^0C at standard pressure, for instance, the figure 24.45 must be replaced by 24.04.

may be an occupational physician, an industrial hygienist or a safety engineer or technician, either in a service organised by the plant itself or attached to an outside body.

Personal sampler: a light and compact portable instrument for sampling the *air* and/or carrying out measurements in the worker's breathing zone, whatever his movements during the period of duty.

Radioactive substance: any substance which emits ionising radiations as the result of fission of its atomic nucleus; radiotoxicity is much higher than chemical toxicity and depends on the radioactivity of the substance (number of nuclear fissions per unit of time), the nature of the radiation emitted, the duration of the radioactivity (half-life) and the metabolism of the substance in the body; radioactive substances may take the form of very fine particles (particle sizes of less than 1μm).

Respirable fibre: any organic or mineral structure or composition with a definite length/diameter ratio which may become deposited in the lung tissue and cause harmful health effects.

Safety factor: a margin of safety embodied in exposure limits during their establishment, when extrapolating to workers data obtained from research or epidemiological studies. As regards experimental data, the guiding criteria for the numerical value to be given to this factor agree to some extent for oral poisoning; allowance is made in particular for the species, weight and sex of the laboratory animal and the biological effects of the substance studied. On the other hand, in the case of experimental poisoning by inhalation, which is the most significant for establishing exposure limits, there are still many sources of uncertainty.

Scientific research institute: a public or private institute or specialised laboratory attached to an undertaking.

Sensitising substance: substance which can increase the sensitivity of one or more body tracts or systems to any stimulus to which they were less sensitive before exposure.

Skin absorption: penetration of a toxic substance into the body either through the horny and fatty layers of the skin in the case of liposoluble substances (such as solvents) or through the hair follicles in the case of many other substances; for the purposes of occupational exposure control, the skin absorption route is considered for practical purposes when toxic effects can follow the absorption of certain substances (e.g. aniline or certain organophosphoric pesticides) merely through direct contact with the skin.

Special category of worker: workers who, on account of their age (adolescents, older workers) or sex (women of childbearing age, pregnant women, nursing mothers) or physical (disabled) or other condition (e.g. enzymatic), may be more sensitive to certain harmful substances than the average worker; this does not necessarily mean that the exposure limits are not applicable to these categories of worker, but that they may not be applicable to a specific individual in one of these categories and that medical precautions are therefore necessary.

Substitute material: substance which offers the same technical advantages as a specific substance, but which is harmless or less harmful.

Teratogen: substance or agent capable of causing the development of post-conception deformations *in utero,* resulting in either abortion or the birth of a malformed offspring.

Toxicity: ability of a substance to cause a reversible or irreversible disturbance of the normal physiological processes of one or more bodily systems; its effects may be asphyxiating, carcinogenic, irritant, mutagenic, radioactive, sensitising, teratogenic, etc.; short-term toxicity tests are experiments involving the administration of the toxic substance over a period corresponding to one-tenth of the life of a laboratory animal; long-term toxicity tests are carried out throughout almost the entire life of the animal.

Vapour: gaseous phase of a substance which is liquid at ordinary temperature and pressure. Vapour pressure is the pressure of the vapour in the medium containing it; the higher this vapour pressure and temperature, the more liquid can vaporise.

Waste: solid or liquid residue from industrial, commercial or agricultural activities: refuse, used lubricants, rubble, empty containers, or radioactive or other scraps.

Working environment: the atmosphere of workplaces, whether enclosed or in the open air; it may, in the case of those which are enclosed, be adversely affected by the movement of contaminated air from other workplaces.

Workplace: place where workers responsible for carrying out or supervising a working operation are located permanently, or temporarily; when the work is performed at different places in a room, the entire room is considered as a workplace.

B. Meeting of Experts on Limits of Exposure to Harmful Airborne Substances (Geneva, 21-28 November 1977)

The following persons attended the Meeting:

Experts nominated on the proposal of governments:

Dr. A. Rothan (France), Chief Medical Officer, Medical Inspectorate of Labour and Manpower, Directorate of Industrial Relations, Ministry of Labour, Paris. *(Chairman)*

Dr. A. Paulino (Brazil), Chairman, National Association for Occupational Health, Santos. *(Reporter)*

Mr. M. Bauer (Czechoslovakia), Deputy Director, Occupational Safety Research Institute, Prague.

Dr. Reynaldo Franco (Argentina), Chief, Technical-Legal Department, National Directorate of Occupational Health and Safety, Ministry of Labour, Buenos Aires.

Dr. Jorma Rantanen (Finland), Director-General, Institute of Occupational Health, Helsinki.

Dr. H. Sakabe (Japan), Director, National Institute of Industrial Health, Kawasaki.

Mr. S. J. Silk* (United Kingdom), Head, Occupational Hygiene Unit, HM Factory Inspectorate, London.

Dr. I. P. Ulanova (USSR), Chief, Toxicological Laboratory, Institute of Industrial Hygiene and Occupational Diseases of the USSR Academy of Medical Sciences, Moscow.

Dr. S. H. Zaidi (India), Director, Industrial Toxicology Research Centre, Lucknow.

Experts nominated after consultation of the Employers' group of the Governing Body of the ILO:

Mr. P. E. Arscott,* Safety Adviser, Engineering Employers' Federation, London.

Dr. J. A. Bisby, Chief Medical Adviser, Shell Group of Companies in Australia, Melbourne.

Dr. J. W. Charters, Medical Director, The Steel Company of Canada Limited, Hamilton.

Sr. Julio César Durân, Argentine Industrial Union, Buenos Aires.

Professor G. Gerhardsson, Scientific Adviser to the Swedish Employers' Confederation, Stockholm.

Mr. H. Loskant, Chief Industrial Physician, Hoechst AG, Confederation of German Employers' Associations, Frankfurt.

Mr. I-fang Mao, Chief, Department of Safety and Health, Tatung Company, Taipei.

Mr. M. Mizuno, Manager, International Division, Japan Federation of Employers' Associations, Tokyo.

Dr. Paulo Monteiro Mendes, Chairman, Standing Technical Committee on Industrial Health and Safety, National Department of the Social Service of Industry (SESI), National Confederation of Industry, Rio de Janeiro.

Dr. P. V. Thacker,* Chief Industrial Health Officer, Tata Services Limited, Fort (Bombay).

Appendix B

Experts nominated after consultation of the Workers' group of the Governing Body of the ILO:

Mr. A. Hornet, General Confederation of Labour (CGT), Paris.

Mr. M. Casadei,* Federation of Textile, Chemistry and Paper Workers, Ciba-Geigy, Occupational Safety Service, Basle.

Mr. F. Chafe,* Executive Assistant to the President, Canadian Labour Congress, Ottawa.

Mr. J. P. Hamilton, Safety Specialist, Social Insurance and Industrial Welfare Department, Trades Union Congress, London.

Mr. V. Nikitin, Deputy Director, All-Union Central Labour Protection Research Institute, All-Union Central Council of Trade Unions of the USSR, Moscow *(Personal adviser:* Mr. A. I. Turcaninov, All-Union Central Council of Trade Unions of the USSR, Moscow).

Mr. T. Reynolds, Compensation Department, Labour Council of New South Wales, Sydney.

Mr. Markku Toropainen, Central Organisation of Finnish Trade Unions (SAK), Helsinki.

Mr. K. N. Trivedi, Safety Officer, Indian National Mineworkers' Federation, Bihar.

The experts whose names are followed by an asterisk (*) made up the working party set up by the Meeting of Experts to examine the draft code of practice.

The following international organisations were represented at the Meeting:

World Health Organization; United Nations Economic Commission for Europe; United Nations Environment Programme; International Register of Potentially Toxic Chemicals; Commission of the European Communities; International Social Security Association; International Agency for Research on Cancer; International Organisation of Employers; World Confederation of Labour; International Organization for Standardization; and Permanent Commission and International Association on Occupational Health.

Index

* Terms or expressions followed by an asterisk (*) are defined in the glossary.

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