

Ambient factors in the workplace



International
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Office
Geneva

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**Ambient factors
in the workplace**

ILO codes of practice

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International Labour Office Geneva

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Preface

In accordance with the decision taken by the Governing Body of the ILO at its 271st Session (March 1998), a meeting of experts was convened in Geneva from 27 January to 2 February 1999 to draw up a code of practice on ambient factors at the workplace. The meeting was composed of 15 experts, five appointed following consultations with governments, five appointed following consultations with the Employers' group and five appointed following consultations with the Workers' group of the Governing Body.¹

¹ *Experts appointed following consultations with governments:*

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World Health Organization (WHO): Ms. Berenice Goelzer.
International Organisation of Employers (IOE): Ms. Barbara Perkins.
International Confederation of Free Trade Unions (ICFTU): Ms. Anna Biondi.
World Confederation of Labour (WCL): Ms. Béatrice Fauchère.
General Confederation of Trade Unions (GCTU): Mr. Vladimir Kouvchinov and Mr. Gueorgui Kanaev.
Arab Labour Organization (ALO): Mr. Adnan El Telawi.
International Metalworkers' Federation (IMF): Mr. Len Powell.
International Construction Institute (ICI): Mr. Francis La Ferla.
International Occupational Hygiene Association (IOHA): Mr. Paul Oldershaw.

Ambient factors in the workplace

In response to technological developments, the code of practice was prepared with a view to updating the ILO's codes of practice on the protection of workers against noise and vibration in the working environment (Geneva, 1984) and on occupational exposure to airborne substances harmful to health (Geneva, 1980). It also intends to consolidate earlier documents on all types of air pollutants and other ambient factors in the working environment and to contribute to the practical implementation of the provisions contained in the Working Environment (Air Pollution, Noise and Vibration) Convention (No. 148), and Recommendation (No. 156), 1977, as well as other international standards.

The provisions of this code should be considered as the basis for eliminating or controlling exposure to hazardous airborne chemicals, ionizing and non-ionizing radiation, ultraviolet, infra-red and (in some circumstances) visible radiation, electric and magnetic fields, noise, vibration, high and low temperatures and humidity.

Notwithstanding the variety of the covered ambient factors, the magnitude of technical aspects that were linked with social policies and economic considerations and the diversity of situations, it was possible to identify some basic overall principles and various options for balancing competing interests, and to determine practical solutions in terms of procedures and allocation of responsibilities.

Therefore, this code places emphasis on the role and obligations of competent authorities, the responsibilities of employers and the duties and rights of workers and others with regard to the prevention of illness and injury to health due to hazardous ambient factors in the working environment. It deals, in particular, with the setting up of legal, administrative and practical procedures and frameworks for the assessment of hazards, risks and of control measures, the aims of and mechanisms for identifying and eliminating or controlling the hazard or risk from hazardous ambient factors; the surveillance of workers' health and of the working environment; and the provision of information and training to workers.

Chapters 2 and 3 provide for general obligations, responsibilities, duties and rights and for general principles of prevention and improvement, applicable to all covered hazardous ambient factors at the workplace.

Additional and specific requirements regarding assessment, prevention and control, health surveillance, and training and information for specific factors are given in Chapters 4 to 10. Further information on occupational exposure limits is provided in the annex.

The experts highlighted that the code of practice provides the basic requirements for the protection of workers' health against hazardous ambient factors. It has been drawn up with the objective of providing guidance to those who may be engaged in the framing of relevant provisions and the setting up of effective systems, procedures and arrangements. The code is of particular relevance to competent authorities, other governmental or public authorities, occupational safety and health services, the management of enterprises, employers and workers, and their organizations.

International Commission on Occupational Health (ICOH): Mr. Ingvar Holmer.
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ILO representatives:

Dr. Jukka Takala, Director, SafeWork – Programme on Safety, Health and the Environment.

Dr. Jürgen Serbitzer, Head of the Engineering Section, SafeWork – Programme on Safety, Health and the Environment.

The experts noted that the provisions of this code do not apply to other ambient factors such as shift work, ergonomic factors and/or psychosocial factors, such as work intensification, repetitive work and stress, which may add to the hazards or risks to safety and health associated to the specific hazardous ambient factors covered by this code.

The practical recommendations of this code of practice are intended for the use of all those who have the responsibility for the protection of workers' health against hazardous ambient factors. The code is not a legally binding document and is not intended to replace national laws, regulations or accepted standards. Its provisions are considered as the basic requirements for the protection of workers' health against hazardous ambient factors and are not intended to discourage competent authorities from adopting higher standards. More stringent national or international regulations have priority over these recommendations.

Local circumstances and the availability of financial and technical resources will determine how far it is practicable to follow the provisions of the code. Furthermore, these provisions should be read in the context of the conditions in the country proposing to use the information. With this in mind, consideration has been taken of the needs of developing countries and of countries which intend to establish or to modify their systems for the protection of workers' health against hazardous ambient factors.

The text of the code was approved for publication by the Governing Body of the ILO at its 274th Session (March 1999).

Requests for further information or assistance may be directed to:

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Contents

Preface	V
1. General provisions	1
1.1. Objectives	1
1.2. Scope.....	2
1.3. Definitions	2
2. General obligations, responsibilities, duties and rights	4
2.1. Role and obligations of the competent authority	4
2.2. General responsibilities of employers.....	5
2.3. General duties of workers	7
2.4. General responsibilities of suppliers, manufacturers, designers and architects	7
2.5. Rights of workers.....	8
2.6. Cooperation.....	9
3. General principles of prevention and control	11
3.1. Assessment of hazards and risks and prevention and control measures.....	11
3.2. Review of assessment	12
3.3. Prevention and control	13
3.4. Surveillance of the working environment.....	15
3.5. Workers' health surveillance	16
3.6. Training and information	19
4. Hazardous substances	21
4.1. Scope.....	21
4.2. Assessment.....	21
4.3. Prevention and control	23
4.4. Health surveillance	24
4.5. Training and information	25
5. Ionizing radiation	27
5.1. Scope and principles	27
5.2. Assessment.....	28
5.3. Prevention and control	30
5.4. Health surveillance	32
5.5. Training and information	32
6. Electric and magnetic fields	33
6.1. Scope.....	33
6.2. Assessment.....	33
6.3. Prevention and control	34
6.4. Health surveillance	35
6.5. Training and information	36
7. Optical radiation	37
7.1. Scope.....	37
7.2. Assessment.....	37

Ambient factors in the workplace

7.3. Prevention and control	38
7.4. Health surveillance.....	40
7.5. Training and information	40
8. Heat and cold	42
8.1. Scope	42
8.2. Assessment.....	42
8.3. Prevention and control in hot environments	43
8.4. Prevention and control in cold environments	45
8.5. Health surveillance.....	47
8.6. Training and information	48
9. Noise.....	49
9.1. Scope	49
9.2. Assessment.....	49
9.3. Prevention and control	50
9.4. Health surveillance.....	52
9.5. Training and information	53
10. Vibration	54
10.1. Scope	54
10.2. Assessment.....	54
10.3. Prevention and control	55
10.4. Health surveillance.....	56
10.5. Training and information	57
Annex : Occupational exposure limits.....	58
1. Purpose	58
2. General	58
3. General sources	59
4. Hazardous substances	59
5. Ionizing radiation	60
6. Electric and magnetic fields	61
7. Optical radiation.....	61
8. Heat and cold	62
9. Noise	62
10. Vibration	63
Further reading	65

1. General provisions

1.1. Objectives

1.1.1. The objectives of this code are:

- (a) to prevent or reduce the incidence and severity of illness and injury arising from specified hazardous ambient factors at work;
- (b) to protect workers from hazards or risks to safety and health resulting from exposure to them;
- (c) to assist and facilitate the improved management of occupational health issues in or about the workplace;

thereby enhancing the protection of the general public and the environment.

1.1.2. This code provides guidance on the role and obligations of competent authorities and the responsibilities, duties and rights of employers, workers and all other parties involved, with regard to hazardous ambient factors, in particular in:

- (a) setting up effective legal and administrative frameworks for the prevention and reduction of hazards and risks;
- (b) the aims of and mechanisms for eliminating, minimizing and controlling hazards;
- (c) the assessment of risk and of the measures that need to be taken;
- (d) the surveillance of the working environment;
- (e) providing information and training to workers.

1.1.3. This code is intended to provide practical guidance on the application of the provisions of the Working Environment (Air Pollution, Noise and Vibration) Convention (No. 148), and Recommendation (No. 156), 1977, the Occupational Safety and Health Convention (No. 155), and Recommendation (No. 164), 1981, the Occupational Health Services Convention (No. 161), and Recommendation (No. 171), 1985, the Chemicals Convention (No. 170), and Recommendation (No. 177), 1990, and the Home Work Convention (No. 177), and Recommendation (No. 184), 1996. More specific guidance on chemicals, particularly classification and labelling, is provided by the ILO code of practice *Safety in the use of chemicals at work* (Geneva, 1993). Where workers are exposed to ionizing radiations as a result of the use of radioactive chemicals, the provisions of the Radiation Protection Convention (No. 115), and Recommendation (No. 114), 1960, the ILO code of practice *Radiation protection of workers (ionizing radiations)* (Geneva, 1987) and *International basic safety standards for protection against ionizing radiation and for the safety of radiation sources* (jointly sponsored by the FAO, IAEA, ILO, OECD/NEA, PAHO and WHO, hereinafter referred to as the “*Basic safety standards*”) apply.

Ambient factors in the workplace

1.2. Scope

1.2.1. The provisions of this code should be considered as the basis for eliminating or controlling exposure to hazardous ambient factors at the workplace, namely hazardous airborne chemicals, ionizing and non-ionizing radiation, ultraviolet, infra-red and (in some circumstances) visible radiation, electric and magnetic fields, noise, vibration, high and low temperatures and humidity.

1.2.2. The provisions of this code apply to all branches of economic activity, all enterprises and to any work activity in which workers may be exposed to hazardous ambient factors.

1.2.3. The provisions also apply to such self-employed persons and homeworkers as are specified in national laws or regulations, who may be affected by hazardous ambient factors during a work activity or whose work may expose others to hazardous ambient factors.

1.3. Definitions

1.3.1. In this code, the following terms have the meanings hereby assigned to them:

Competent authority: A minister, government department or other public authority with the power to issue regulations, orders or other instructions having the force of law. Under national laws or regulations, the competent authorities may be appointed with responsibilities for specific activities, such as for implementation of national policy and procedures for the prevention of risks from ambient factors.

Competent person: A person with suitable training and sufficient knowledge, experience and skill for the performance of the specific work, in good safety conditions. The competent authority may define appropriate criteria for the designation of such persons and may determine the duties to be assigned to them.

Exposure limit: An exposure level specified or recommended by a competent authority to limit injury to health. It is used as a general term and covers the various expressions employed in national lists, such as “maximum allowable concentration”, “threshold limit value”, “permissible level”, “limit value”, “average limit value”, “permissible limit”, “industrial hygiene standards”, “occupational exposure limit”, etc.

Hazard: Inherent potential of an ambient factor to cause illness or injury from exposure to it.

Hazard assessment: Systematic evaluation of the intrinsic properties of ambient factors, including the extent of the inherent potential to cause illness or injury.

Hazardous ambient factor: Any factor in the workplace which may in some or all normal conditions adversely affect the safety and health of the worker or other person.

General provisions

Occupational health services: Services entrusted with essentially preventive functions and responsible for advising the employer, the workers and their representatives in the undertaking on:

- (a) the requirements for establishing and maintaining a safe and healthy working environment which will facilitate optimal physical and mental health in relation to work;
- (b) the adaptation of work to the capabilities of workers in the light of their state of physical and mental health.

Occupational health surveillance: Ongoing systematic collection, analysis, interpretation, and dissemination of data for the purpose of planning, implementation and evaluation of occupational health programmes, control of work-related ill health and injuries and the protection and promotion of workers' health. Occupational health surveillance includes workers' health surveillance and working environment surveillance.

Risk: Likelihood that exposure to a hazardous ambient factor will cause illness or injury.

Riskassessment: Systematic evaluation and/or quantification of risk, arising from exposure to a hazardous ambient factor taking into account the severity of consequences of exposure and available control measures.

Surveillance of the working environment: Generic term which includes the identification and evaluation of environmental factors which may adversely affect workers' health. It covers assessments of sanitary and occupational hygiene conditions, factors in the organization of work which may pose hazards or risks to the safety and health of workers, collective and personal protective equipment, exposure of workers to hazardous agents and control systems to eliminate or reduce them.

Workers' health surveillance: Generic term which covers procedures and investigations to assess workers' health in order to detect, identify and quantify any abnormality and to protect and promote the health of the individual, collective health at the workplace, and the health of the exposed working population. Health assessment procedures may include, but are not limited to, medical examinations, biological monitoring, radiological examinations, questionnaires or a review of health records.

Workers' representatives: Persons who are recognized as such by national law or practice, in accordance with the Workers' Representatives Convention, 1971 (No. 135).

2. General obligations, responsibilities, duties and rights

2.1. Role and obligations of the competent authority

2.1.1. The competent authority should, in the light of national conditions and practice, and in consultation with the most representative organizations of employers and workers concerned, formulate, implement and periodically review a coherent national policy (hereafter referred to as “the policy”) for eliminating or controlling hazardous ambient factors. This should form part of the overall policy on occupational safety and health and the working environment as required by the Occupational Safety and Health Convention, 1981 (No. 155). The policy should provide an adequate and appropriate framework to bring about practical action, and should be consistent with the protection of the general public and the environment.

2.1.2. The policy should:

- (a) aim at preventing illness and injury to health arising out of, linked with or occurring in the course of work, by identifying and eliminating or controlling the hazard or risk from hazardous ambient factors in the working environment;
- (b) be supported by laws and regulations and have a mechanism of inspection for their enforcement;
- (c) establish general principles and uniform procedures for the assessment of hazards, risks and control measures and for appropriate occupational health surveillance;
- (d) initiate and reinforce appropriate national activities such as monitoring the extent of illness or injury, coordinating national research efforts into hazardous ambient factors, and coordinating and promoting appropriate campaigns on hazardous ambient factors at the workplace.

2.1.3. To give effect to the policy, the competent authority should:

- (a) review periodically existing national conditions and practice for eliminating or controlling risks to health from hazardous ambient factors at work, with a view to identifying major problems, evolving effective methods for dealing with them, setting priorities for action, and evaluating results;
- (b) implement adequate and appropriate measures, including any necessary changes to laws and regulations.

2.1.4. The competent authority or a body approved or recognized by it should establish, review and update exposure limits or other exposure criteria for the evaluation and control of the working environment in accordance with national or internationally recognized technical standards.

2.1.5. The competent authority should secure the enforcement of national laws and regulations concerning the policy through an adequate and appropriate system of inspection. The system of enforcement should provide for corrective measures and adequate penalties for violations of national laws and regulations concerning the policy.

Obligations, responsibilities, duties and rights

2.1.6. If justified on safety and health grounds, the competent authority should have the power to:

- (a) prohibit or restrict the use of certain hazardous processes or substances; or
- (b) require advance notification and authorization before such processes or substances are used; or
- (c) specify categories of workers who, for reasons of safety and health, are not allowed to use specified processes or substances or are allowed to use them but only under conditions prescribed in accordance with national laws or regulations.

2.1.7. The competent authority should ensure that guidance is provided to employers and workers to help them comply with their legal obligations under the policy.

2.1.8. In appropriate cases, the competent authority should prescribe general procedures for cooperation between employers whenever two or more enterprises engage in activities on the same project at one workplace.

2.1.9. The competent authority should make special provisions to protect confidential information whose disclosure to a competitor would be liable to cause harm to an employer's business so long as the safety and health of workers are not compromised thereby.

2.2. General responsibilities of employers

2.2.1. Employers should comply with the safety and health measures to be taken regarding hazards or risks to safety and health from hazardous ambient factors at work, including appropriate standards, codes and guidelines as prescribed, approved or recognized by the competent authority.

2.2.2. Employers should provide and maintain workplaces, plant, equipment, tools and machinery and organize work so as to eliminate or control hazardous ambient factors at work, and be consistent with national laws and regulations.

2.2.3. Employers should set out in writing their respective programmes and arrangements, as part of their general policy and arrangements in the field of occupational safety and health, and the various responsibilities exercised under these arrangements. This information should be clearly communicated to their workers.

2.2.4. Employers, in consultation with workers and/or their representatives, should:

- (a) make an assessment of the hazards and risks to safety and health of workers arising from hazardous ambient factors at work, requesting and making effective use of the information provided by the supplier of equipment or chemicals and from other reasonably available sources;

Ambient factors in the workplace

- (b) take all practicable measures to reduce exposure to hazardous ambient factors and in any case ensure that the exposure does not exceed exposure limits prescribed by the competent authority; and
- (c) give due consideration to the particular hazards or risks associated with hazardous ambient factors which have reproductive, teratogenic, mutagenic and/or endocrine disruptive effects.

2.2.5. In taking preventive and protective measures, the employer should address the hazardous factor or risk in the following order of priority:

- (a) eliminate the hazardous factor or risk;
- (b) control the hazardous factor or risk at source;
- (c) minimize the hazardous factor or risk by means that include the design of safe work systems;
- (d) in so far as the hazardous factor or risk remains, provide for the use of personal protective equipment, including clothing, as appropriate, at no cost to the workers, and implement measures to ensure its use;

having regard to what is reasonable, practicable and feasible, and to good practice and the exercise of due diligence.

2.2.6. In accordance with national laws and regulations, employers should make the necessary arrangements to provide for:

- (a) regular surveillance of the working environment and where necessary occupational health surveillance;
- (b) adequate and competent supervision of work and work practices;
- (c) the application and use of appropriate control measures and the periodic review of their effectiveness; and
- (d) appropriate and periodic education and training to workers and, where appropriate, to workers' representatives, on issues relating to hazardous ambient factors.

2.2.7. Employers should make arrangements to:

- (a) deal with accidents, dangerous occurrences and incidents which may involve hazards or risks to safety and health from hazardous ambient factors;
- (b) eliminate or control any damage to the safety and health of workers, and thereby to the public and the environment.

2.2.8. Where an employer is also a national or multinational enterprise with more than one establishment, the employer should provide safety and health measures relating to the prevention and control of, and protection against, injuries and risks to safety and health from hazardous ambient factors, without discrimination, to all workers.

2.2.9. In all countries in which they operate, multinational enterprises should make available to their workers and to the representatives of the workers in the enterprise, and upon request to the competent authorities and the workers' and

Obligations, responsibilities, duties and rights

employers' organizations, information on the standards related to injuries and risks to safety and health from hazardous ambient factors at work, relevant to their local operations, which they observe in other countries.

2.3. General duties of workers

2.3.1. Workers should have the duty, in accordance with their training, the instructions and the means given by their employers:

- (a) to comply with prescribed safety and health measures;
- (b) to take all reasonable steps to eliminate or control hazards or risks to themselves and to others from hazardous ambient factors at work, including proper care and use of protective clothing, facilities and equipment placed at their disposal for this purpose;
- (c) to report forthwith to their immediate supervisor any situation which they believe could present a hazard or risk to their safety and health or that of other persons arising from hazardous ambient factors at work, and which they cannot properly deal with themselves;
- (d) to cooperate with the employer and other workers to permit compliance with the duties and responsibilities placed on the employer and workers pursuant to national laws and regulations.

2.4. General responsibilities of suppliers, manufacturers, designers and architects

2.4.1. Measures should be taken, in accordance with national law and practice, to ensure that those who design, manufacture, import, provide or transfer machinery, equipment or substances for occupational use:

- (a) satisfy themselves, as far as is reasonable and practicable, that the machinery, equipment or substance does not entail dangers for the safety and health of those using it correctly;
- (b) make available:
 - (i) information concerning the correct installation and use of machinery and equipment and the correct use of substances;
 - (ii) information concerning hazards of machinery and equipment; dangerous properties of hazardous substances; and physical agents or products;
 - (iii) instructions on how known hazards are to be avoided.

2.4.2. Suppliers of equipment, processes and hazardous substances, whether manufacturers, importers or distributors, should ensure so far as is practicable that the design is such as to eliminate or control the hazards and risks to safety and health from hazardous ambient factors at work. Where suppliers become aware of new information

Ambient factors in the workplace

concerning the hazards and risks presented by equipment, processes and hazardous substances, they should provide, as appropriate, updated information and instructions.

2.4.3. Designers should ensure, as far as is practicable, that the levels of hazardous ambient factors emitted from plant and processes are minimized and that they conform to internationally recognized plant and equipment standards.

2.4.4. Architects, designers and others responsible for the design and construction of buildings and workplaces should ensure, in close cooperation with relevant specialists, that their designs promote a safe and healthy working environment.

2.5. Rights of workers

2.5.1. Workers and their representatives should have the right to:

- (a) be consulted regarding any hazards or risks to safety and health from hazardous ambient factors at work;
- (b) inquire into and receive information from the employer regarding any hazards or risks to safety and health from hazardous ambient factors at work, including information from suppliers. This information should be provided in forms and languages easily understood by the workers;
- (c) take adequate precautions, in cooperation with their employer, to protect themselves and other workers against hazards or risks to safety and health from hazardous ambient factors;
- (d) request and be involved in the assessment of hazards and risks to safety and health from hazardous ambient factors to be conducted by the employer and/or by the competent authority, and in relevant control measures and investigations.

2.5.2. Workers and/or their representatives should be involved in the inception and development of workers' health surveillance, and participate and cooperate with occupational health professionals and their employers in its implementation.

2.5.3. Workers should be informed in a timely, objective and comprehensible manner:

- (a) of the reasons for the examinations and investigations relating to the health hazards involved in their work;
- (b) individually of the results of the medical examinations, including pre-assignment medical examinations, and of the respective assessment of health. The results of medical examinations should not be used to unlawfully discriminate against workers.

2.5.4. In accordance with national laws and regulations, workers should have the right:

- (a) to bring to the attention of their representatives, the employer or the competent authority hazards or risks to safety and health from ambient factors at work;

Obligations, responsibilities, duties and rights

- (b) to appeal to the competent authority if they consider that the measures taken and the means employed by the employer are inadequate for the purposes of ensuring safety and health at work;
- (c) to remove themselves from danger resulting from hazardous ambient factors when they have reasonable justification to believe that there is an imminent and serious risk to their safety and health. Such workers should inform their supervisor immediately;
- (d) in the case of a health condition, such as sensitization, placing them at increased risk of harm from an ambient factor, to be transferred to alternative work not exposing them to that increased risk, if such work is available and if the workers concerned have the qualifications or can reasonably be trained for such alternative work;
- (e) to compensation if the case referred to in (d) above results in loss of employment;
- (f) to adequate medical treatment and compensation for occupational injuries and diseases resulting from hazardous ambient factors at work;
- (g) to refrain from using equipment or a process or substance which can reasonably be expected to be hazardous, if the relevant information is not available to assess the hazards or risks to safety and health.

2.5.5. Workers who remove themselves from danger in accordance with the provisions of paragraph 2.5.4 (c) should be protected against undue consequences in accordance with national conditions and practice.

2.5.6. Workers who justifiably take those actions specified in paragraph 2.5.4 (a), (b) and (g) should be protected against unwarranted discrimination, for which there should be recourse in national laws and practice.

2.5.7. Workers should receive training and, where necessary, retraining in the most effective methods which are available for minimizing risks to safety and health from ambient factors at work, in particular in those areas referred to in paragraph 3.6.2 of this code.

2.5.8. Women workers should have the right, in the case of pregnancy or during lactation, to alternative work not hazardous to the health of the unborn or nursing child arising from exposure to hazardous ambient factors, where such work is available, and to return to their previous jobs at the appropriate time.

2.6. Cooperation

2.6.1. Employers, workers and their representatives should cooperate as closely as possible in the application both of the measures provided by this code and of the provisions of the Working Environment (Air Pollution, Noise and Vibration) Convention (No. 148), and Recommendation (No. 156), 1977; the Occupational Safety

Ambient factors in the workplace

and Health Convention (No. 155), and Recommendation (No. 164), 1981; the Occupational Health Services Convention (No. 161), and Recommendation (No. 171), 1985; and the Chemicals Convention (No. 170), and Recommendation (No. 177), 1990, to ensure the elimination or control of hazards or risks to safety and health from hazardous ambient factors at work.

2.6.2. In accordance with national laws and regulations, measures for cooperation relating to the elimination or control of risks to safety and health from hazardous ambient factors should be taken, including the following:

- (a) employers, in discharging their responsibilities, should cooperate as closely as possible with workers and/or their representatives;
- (b) workers should cooperate as closely as possible with their fellow workers and their employers in the discharge by the latter of their responsibilities and should comply with all prescribed procedures and practices;
- (c) suppliers should provide employers with such information as is available and required for the evaluation of any unusual hazards or risks to safety and health which might result from a particular hazardous ambient factor at work.

3. General principles of prevention and control

3.1. Assessment of hazards and risks and prevention and control measures

3.1.1. Employers should make periodic assessments of the hazards and risks to safety and health from hazardous ambient factors at each permanent or temporary workplace and implement the control measures required to prevent those hazards and risks, or to reduce them to the lowest reasonable and practicable level. If a new source of hazard is introduced, the assessment should be made before workers are exposed to the hazard. The assessment should gather information on the hazardous ambient factors present at the workplace, the degree of exposure and risk, appropriate control measures, health surveillance, and training and information. The assessment should be reviewed whenever there is a reason for it (see section 3.2). Later chapters of this code give guidance on how these principles should be applied to particular hazards.

3.1.2. The assessment should be carried out in consultation with workers and/or their representatives by the employers or by persons acting on their behalf who are competent and have the necessary information, instruction and training. Where the outcome of the assessment indicates a potential injury or risk to safety and health, the results of the assessment should be recorded and made available for inspection by the competent authority, and to workers exposed to the hazardous ambient factors and the workers' representatives. The record of the assessment should be retained for a period of time as may be specified by the competent authority.

3.1.3. The *first stage of the assessment* should include inspection of the workplace in order to identify:

- (a) what hazardous ambient factors are present or likely to occur, including hazardous substances, ionizing and non-ionizing radiation, hazardous optical radiation, electric or magnetic fields, noise and vibration, and extremes of temperature and humidity, including the work organization;
- (b) what activities are likely to expose workers and others to the hazardous ambient factors identified, including maintenance, cleaning and emergency procedures.

3.1.4. The *second stage of the assessment* should consist of the collection of information about the hazardous ambient factors present or likely to occur in order to determine the magnitude and significance for safety and health of any hazard or risk which may occur including the relevance of work organization, and the practicability of various methods of control. The information should include that provided by suppliers (see paragraph 2.4.1 above) and other information in the public sphere. Determining the magnitude of the hazard or risk should include determining the exposure of the workers to the factors, unless other information is adequate for quantification of the risk. The exposure levels should be compared with those exposure limits or standards prescribed by the competent authority. Where there are no such limits or standards, other national or internationally recognized standards should be used for comparison. In either case,

Ambient factors in the workplace

account should be taken as to the basis on which those limits have been set (see Annex of this code).

3.1.5. The *third stage of the assessment* should establish whether hazards or risks to safety and health can be eliminated. If they cannot be eliminated, the employer should plan how they can be reduced to the lowest practicable level, or to a level which, in the light of currently available national and international knowledge and data, would not lead to injury if exposure continued for a working lifetime.

3.1.6. As part of the assessment, the employer should:

- (a) determine what instructions, training and information need to be given to the workers and, where appropriate, to their representatives, and others likely to be exposed to the hazardous factors;
- (b) determine what measures are needed to ensure that the information is kept up to date;
- (c) plan for necessary training to be given to new or transferred workers;
- (d) ensure that a programme for review of the assessment, including future monitoring of exposure levels, is established.

3.1.7. The frequency and type of future monitoring of exposure levels will depend on the exposure found in relation to recognized exposure limits. If the exposure level is very much lower than the limit and there is no change in process or other reason (see paragraph 3.2.2 below), then repeat measurement may only be needed occasionally. If the exposure level is relatively high, then measurement may be needed several times between assessment reviews, to ensure that these levels have not been altered by some unidentified factor.

3.2. Review of assessment

3.2.1. The assessment should be reviewed whenever there has been a significant change in the work to which it relates or when there is reason to suspect that it is no longer valid. The review should be incorporated in a system of management accountability which ensures that control action shown to be necessary by the initial assessment is in fact taken.

3.2.2. Reasons indicating that an assessment might no longer be valid might include:

- (a) complaints by workers of adverse health effects and detection of health impairment;
- (b) an accident, dangerous occurrence or incident leading to exposure to hazardous ambient factors or risks which is different from that quantified in the initial assessment;
- (c) subsequent measurement of exposure levels;

General principles of prevention and control

- (d) availability of updated information on the hazards or risks of hazardous ambient factors;
- (e) plant modification, including engineering control measures, changes in the process or methods of work and in the volume or rate of production which lead to a change in the hazardous ambient factors present.

3.2.3. The review should reconsider all parts of the initial assessment, and in particular whether it is now:

- (a) practicable to eliminate any hazardous ambient factors;
- (b) possible to control at source and minimize hazards or risks which had previously required personal protective equipment.

3.2.4. The review should consider the results of the programme for monitoring of exposure levels (see paragraph 3.1.6 (d) above), and whether:

- (a) exposure levels previously considered to be acceptable should now be regarded as too high in the light of available and updated information on the hazards and risks of hazardous ambient factors;
- (b) any control action needs to be taken;
- (c) the frequency and type of monitoring decided under paragraph 3.1.7 above is still appropriate.

3.2.5. The results of the review should be recorded and made available in the same way as the initial assessment.

3.3. Prevention and control

3.3.1. The employer should take appropriate measures for the prevention and control of, and protection against, occupational hazards in the working environment due to hazardous ambient factors.

3.3.2. Employers should eliminate and control hazards or risks to the safety and health of workers from hazardous ambient factors by:

- (a) using machinery, equipment or substances which do not entail dangers for the safety and health of those using them correctly;
- (b) substituting hazardous processes, substances or equipment;
- (c) applying technical measures to new plant or processes at the design or installation stage.

3.3.3. Where the assessment under section 3.1 above shows that elimination of hazardous ambient factors is not practicable for existing plants or processes, employers should apply technical measures to control the hazard or risk at its source, by totally enclosing process and handling systems, by isolating workers from hazardous ambient factors, or by other appropriate measures, so that exposure will be reduced to a level

Ambient factors in the workplace

which, in the light of currently available national and international knowledge and data, does not damage the health of workers, even if exposure continues for the duration of their working life.

3.3.4. Where the assessment shows that elimination and total enclosure are both impracticable, employers should reduce exposure as much as possible by technical measures (ventilation in the case of airborne substances, barriers in the case of noise) in combination with organizational measures, so as to:

- (a) reduce the source of the hazard as far as is practicable, so that risks are confined to small areas where engineering control measures can be applied effectively;
- (b) adopt adequate work practices and working time arrangements so that workers' exposure to those factors is effectively controlled;
- (c) minimize the magnitude of exposure, the number of workers exposed and the duration of exposure, by ensuring that:
 - (i) engineering control measures are properly used and maintained;
 - (ii) contaminated walls, surfaces, etc. are regularly and effectively cleaned, if this is relevant to the ambient factors in question;
 - (iii) there is effective provision for safe storage and disposal of hazardous substances and other sources of exposure; and
 - (iv) areas where there is significant risk from exposure to hazardous ambient factors are clearly marked by warning symbols or signs.

3.3.5. Where adequate protection against exposure to hazardous ambient factors cannot be ensured by the above means, suitable personal protective equipment (PPE) and protective clothing, having regard to the type of work and risks, and in consultation with workers and/or their representatives, should be provided and maintained by the employer, without cost to the workers, as may be prescribed by national laws and regulations.

3.3.6. PPE and protective clothing should comply with standards set by the competent authority, or recognized by national or international bodies, taking ergonomic principles into account.

3.3.7. Employers should provide the workers with the appropriate instructions and means to enable them to use PPE and protective clothing properly.

3.3.8. A person having a full understanding of the nature of the hazard and the type, range and performance of the protection required should arrange for items of PPE and protective clothing to be properly stored, maintained, cleaned and, if necessary for health reasons, disinfected or sterilized at suitable intervals.

3.3.9. Workers should be required to make proper use of and to take good care of PPE and protective clothing provided for their use.

General principles of prevention and control

3.3.10. In taking preventive and protective measures, employers should consider the use of PPE where all other measures are either impracticable or could not secure safe and healthy working conditions, taking into account that:

- (a) proper maintenance and use of PPE, including appropriate behaviour of the user, are essential for providing the protection for which it is designed;
- (b) PPE itself may produce uncomfortable, unhealthy or unsafe working conditions;
- (c) only the user is protected, while others coming into the environment continue to be exposed;
- (d) PPE can provide a false sense of security, in particular when it is not properly used or has lost its effectiveness as a result of improper storage or maintenance;
- (e) PPE may introduce additional hazards to the workforce.

3.4. Surveillance of the working environment

3.4.1. The surveillance of the working environment should include:

- (a) identification and evaluation of the hazardous ambient factors which may affect the workers' safety and health;
- (b) assessment of conditions of occupational hygiene and factors in the organization of work which may give rise to hazards or risks to the safety and health of workers;
- (c) assessment of collective and personal protective equipment;
- (d) assessment where appropriate of exposure of workers to hazardous agents, using valid and generally accepted monitoring methods;
- (e) assessment of control systems designed to eliminate or reduce exposure.

3.4.2. Such surveillance should be carried out in liaison with the other technical services of the undertaking and in cooperation with the workers concerned and their representatives in the undertaking and/or the safety and health committee, where they exist.

3.4.3. In accordance with national law and practice, data resulting from the surveillance of the working environment should be appropriately recorded which should be available to the employer, the workers and their representatives in the undertaking concerned or the safety and health committee, where they exist.

3.4.4. These data should be used on a confidential basis and solely to provide guidance and advice on measures to improve the working environment and the health and safety of workers.

3.4.5. The competent authority should have access to these data. They may only be communicated to other persons with the agreement of the employer and the workers or their representatives in the undertaking or the safety and health committee, where they exist.

Ambient factors in the workplace

3.4.6. The surveillance of the working environment should entail such visits by the personnel providing occupational health services as may be necessary to examine the factors in the working environment which may affect the workers' health, the environmental health conditions at the workplace and the working conditions.

3.4.7. Without prejudice to the responsibility of each employer for the safety and health of workers in his/her employment, and with due regard to the necessity for the workers to participate in matters of occupational safety and health, personnel providing occupational health services should have such of the following functions as are adequate and appropriate to the occupational risks of the undertaking:

- (a) monitor workers' exposure to hazardous ambient factors, when necessary;
- (b) advise on the possible impact on the workers' health of the use of certain technologies;
- (c) participate in and advise on the selection of the equipment necessary for the personal protection of the workers against occupational hazards;
- (d) collaborate in job analysis and in the study of organization and methods of work with a view to securing a better adaptation of work to the workers;
- (e) participate in the analysis of occupational accidents and occupational diseases and in accident-prevention programmes;
- (f) supervise sanitary installations and other facilities provided by the employer for the workers, such as drinking-water supply, canteens and living accommodation.

3.4.8. Personnel providing occupational health services should, after informing the employer, workers and their representatives, where appropriate:

- (a) have free access to all workplaces and to the installations the undertaking provides for the workers;
- (b) have access to information concerning the processes, performance standards, products, materials and substances used or whose use is envisaged, subject to their preserving the confidentiality of any secret information they may learn which does not relate to the safety and health of workers;
- (e) be able to take for the purpose of analysis samples of products, materials and substances used or handled.

3.4.9. Personnel providing occupational health services should be consulted concerning proposed modifications in the work processes or in the conditions of work liable to have an effect on the safety and health of workers.

3.5. Workers' health surveillance

3.5.1. Workers' health surveillance should be carried out in consultation with workers and/or their representatives:

General principles of prevention and control

- (a) with the central purpose of primary prevention of occupational and work-related injuries and diseases;
- (b) under controlled conditions and within an organized framework, as may be prescribed by national laws and regulations and in accordance with the ILO Occupational Health Services Convention (No. 161), and Recommendation (No. 171), 1985, and the ILO *Technical and ethical guidelines for workers' health surveillance* (Geneva, 1998).

3.5.2. The organization of workers' health surveillance at different levels (national, industry, enterprise) should take into account:

- (a) the need for a thorough investigation of all work-related factors and the nature of occupational hazards and risks in the workplace which may affect workers' health;
- (b) the health requirements of the work and the health status of the working population;
- (c) the relevant laws and regulations and the available resources;
- (d) the awareness of workers and employers of the functions and purposes of such surveillance;
- (e) the fact that surveillance is not a substitute for monitoring and control of the working environment.

3.5.3. In accordance with the needs and available resources, workers' health surveillance should be carried out at national, industry, enterprise and/or other appropriate levels. Provided that surveillance is carried out or supervised by qualified occupational health professionals, as prescribed by national laws and regulations, it can be undertaken by:

- (a) occupational health services established in a variety of settings, e.g. within one enterprise or among enterprises;
- (b) occupational health consultants;
- (c) the occupational and/or public health facilities available in the community where the enterprise is located;
- (d) social security institutions;
- (e) worker-run centres;
- (f) contracted professional institutions or other bodies authorized by the competent authority;
- (g) a combination of any of the above.

3.5.4. A comprehensive system of workers' health surveillance should:

- (a) include individual and collective health assessments, occupational injury and disease recording and notification, sentinel event notification, surveys, investigations and inspections;
- (b) comprise the collection of information from various sources, and the analysis and evaluation with regard to quality and intended use;

Ambient factors in the workplace

- (c) determine action and follow-up, including:
 - (i) guidance on health policies and occupational safety and health programmes;
 - (ii) early-warning capabilities so that the competent authority, employers, workers and their representatives, occupational health professionals and research institutions can be alerted to existing or emerging occupational safety and health problems.

3.5.5. Medical examinations and consultations as the most commonly used means of health assessment of individual workers, either as part of screening programmes or on an as-needed basis, should serve the following purposes:

- (a) the assessment of the health of workers in relation to hazards or risks caused by exposure to hazardous ambient factors, giving special attention to those workers having specific needs for protection in relation with their health condition;
- (b) detection of pre-clinical and clinical abnormalities at a point when intervention is beneficial to individual health;
- (c) prevention of further deterioration in workers' health;
- (d) evaluation of the effectiveness of control measures in the workplace;
- (e) reinforcement of safe methods of work and health maintenance;
- (f) assessment of fitness for a particular type of work with due regard for the adaptation of the workplace to the worker, taking into account individual susceptibility.

3.5.6. Pre-assignment medical examinations, where appropriate, carried out before or shortly after employment or assignment, should:

- (a) collect information which serves as a baseline for future health surveillance;
- (b) be adapted to the type of work, vocational fitness criteria and workplace hazards.

3.5.7. During employment, medical examinations should take place at periodic intervals, as prescribed by national laws and regulations, and be appropriate to the occupational risks of the enterprise. These examinations should also be repeated:

- (a) on resumption of work after a prolonged absence for health reasons;
- (b) at the request of the worker, for example in the case of change of work and, in particular, change of work for health reasons.

3.5.8. Where persons have been exposed to hazardous ambient factors and, as a consequence, there is a significant risk to their health in the long term, suitable arrangements should be made for post-employment medical surveillance for the purposes of ensuring the early diagnosis and treatment of such diseases.

3.5.9. Biological tests and other investigations should be prescribed by national laws and regulations. They should be subject to the workers' informed consent and performed according to the highest professional standards and least possible risk. These tests and investigations should not introduce unnecessary new hazards to the workers.

General principles of prevention and control

3.5.10. Genetic screening, in accordance with the ILO Code of practice *Protection of workers' personal data* (Geneva, 1997), should be prohibited or limited to cases explicitly authorized by national legislation.

3.5.11. Competent authorities should ensure that laws and regulations governing workers' health surveillance are properly applied.

3.5.12. Workers' personal medical data should:

- (a) be collected and stored in conformity with medical confidentiality, in accordance with the ILO code of practice *Protection of workers' personal data* (Geneva, 1997);
- (b) be used to protect the health of workers (physical, mental and social well-being) individually and collectively, in accordance with the ILO *Technical and ethical guidelines for workers' health surveillance* (Geneva, 1998).

3.5.13. The results and records of workers' health surveillance should:

- (a) be clearly explained by professional health personnel to the workers concerned or to persons of their choice;
- (b) not be used for unwarranted discrimination, for which there should be recourse in national law and practice;
- (c) be made available to the competent authority, at its request, or to any other party agreed by both employers and workers, to prepare appropriate health statistics and epidemiological studies, provided anonymity is maintained, where this may aid in the recognition and control of occupational injuries and diseases;
- (d) be kept during the time and under conditions prescribed by national laws and regulations, with appropriate arrangements to ensure that workers' health surveillance records are securely maintained for establishments that have closed down.

3.6. Training and information

3.6.1. Employers should ensure that the workers have sufficient information to protect their health from hazardous ambient factors which may be present, that this information is in a form and language that they understand, and that they are given sufficient training to understand the information and to take the necessary protective measures.

3.6.2. The form and the content of the information and training should be devised and implemented in consultation with workers and/or their representatives and should be in accordance with the needs identified in the assessment, and may include:

- (a) pertinent aspects of occupational safety and health legislation, such as the rights, responsibilities and duties of competent authorities, employers and workers;

Ambient factors in the workplace

- (b) the nature and degree of hazards or risks to safety and health from hazardous ambient factors which may occur, including any factors which may influence that risk, such as appropriate hygiene practices;
- (c) the correct and effective use of prevention, control and protection measures, especially engineering control measures, and the workers' own responsibility for using such measures properly and for prevention and control of their exposure to hazardous ambient factors;
- (d) correct methods for the handling of substances, the operation of processes and equipment, and for storage, transport and waste disposal;
- (e) assessments, reviews and exposure measurement and the rights and duties of workers in this regard;
- (f) the role of health surveillance, the rights and duties of workers in this regard, and access to information;
- (g) instructions on personal protective equipment as may be necessary, its importance, correct use and limitations, and in particular on factors which may show inadequacy or malfunction of the equipment, and the measures which may be required for the workers to protect themselves;
- (h) warning signs and symbols for hazardous ambient factors which may be present;
- (i) emergency and first-aid measures;
- (j) appropriate hygiene practices to prevent, for example, the transmission of hazardous substances to the home or family environment;
- (k) cleaning, maintenance, storage and waste disposal to the extent that these may cause exposure for the workers concerned;
- (l) procedures to be followed in an emergency.

3.6.3. Employers should ensure that training and information requirements and procedures are kept under review, as part of the assessment review (see section 3.2 of this code).

3.6.4. Training programmes and the provision of information should be at no financial cost to workers, and should take place during working hours, if possible.

4. Hazardous substances

4.1. Scope

4.1.1. This chapter contains additional and specific requirements and information for hazardous substances (including dusts, fumes and gases) to help employers, workers and competent authorities apply the general principles set out in Chapters 2 and 3. Many of the measures described here apply to biological substances, but no attempt was made to cover the special control measures required for infectious materials, which will be the subject of another planned ILO publication.

4.1.2. In the application of the provisions in this chapter, due consideration should be given to the fluctuations in different ambient factors that may exacerbate the adverse effects on the health of workers, the general public and the environment.

4.1.3. Where the workers are exposed to hazardous chemicals (dusts, fumes, gases), the provisions of the ILO code of practice *Safety in the use of chemicals at work* (Geneva, 1993) should apply.

4.1.4. Exposure to hazardous substances should be kept as low as reasonable and practicable, and within the established exposure limits.

4.2. Assessment

4.2.1. As the *first stage of the assessment*, the employer should inspect the workplace and obtain information on:

- (a) hazardous substances that are present or likely to occur, along with other hazardous ambient factors (see paragraph 3.1.3 above);
- (b) activities that take place;
- (c) any hazardous substances or processes that may easily be eliminated.

4.2.2. Consideration should be given to obtaining information on:

- (a) the intrinsic hazards of the raw materials, products and byproducts according to the physical states (e.g. solid, liquid, gas) in which they occur or are produced;
- (b) the ambient conditions (e.g. barometric pressure, temperature, etc.) under which the hazardous substances are used or produced;
- (c) the impact of either the change in phase of the hazardous substances (e.g. solid to liquid phase) or fluctuations in the ambient conditions on the health of workers exposed, the public and the environment.

4.2.3. In the case of chemicals, the employer should obtain information from suppliers in accordance with the provisions of Chapter 5 of the ILO code of practice *Safety in the use of chemicals at work* (Geneva, 1993). Where this is not practicable,

Ambient factors in the workplace

employers should obtain information provided by other bodies such as the International Agency for Research on Cancer (IARC), the International Programme on Chemical Safety (IPCS), the European Communities and other international and national institutions.

4.2.4. Where the risk is from exposure to mineral or synthetic fibres, mineral dusts and vegetable dusts, employers should consider the provisions in the Asbestos Convention (No. 162), and Recommendation (No. 172), 1986; ILO codes of practice *Occupational exposure to airborne substances harmful to health* (Geneva, 1980) and *Safety in the use of asbestos* (Geneva, 1984); the ILO guide on *Safety and health in the use of agrochemicals* (Geneva, 1991); and *Dust control in the working environment (silicosis)* (Geneva, 1997) (ILO Occupational Safety and Health Series No. 36).

4.2.5. When obtaining information for assessment, employers should take account of specific work situations where workers are likely to be exposed, for example, to:

- (a) hazardous fumes as by-products (e.g. welding);
- (b) hazardous substances and/or oxygen deficiency in confined spaces;
- (c) prolonged periods (such as during overtime) with the risk of accumulation of higher doses;
- (d) higher concentrations due to fluctuations in ambient conditions (e.g. hot environments where vapour pressures of hazardous substances may be elevated);
- (e) absorption through multiple routes (inhalation, ingestion, absorption through the skin);
- (f) hazardous substances that may be present even in concentrations below exposure limits while performing arduous tasks.

4.2.6. In the situations listed in paragraph 4.2.5 above the exposure limits specified by the competent authority for normal work situations would often be invalid. Employers should accordingly obtain practical information from the competent authority, international organizations and institutions (ILO, WHO, IPCS) or other bodies.

4.2.7. As the *second stage of the assessment*, the employer should use the information obtained to assess the risk to health resulting from exposure, especially from the effects of chemical mixtures, and should also take account of:

- (a) routes of entry (skin, inhalation, ingestion);
- (b) the risk of penetration through damaged skin or seepage through personal protective equipment;
- (c) the risk of ingestion (due to personal hygiene levels and cultural variations);
- (d) levels of airborne concentrations of hazardous substances;
- (e) the rate at which work is performed (e.g. arduous tasks);
- (f) the length of exposure (e.g. higher exposures resulting from prolonged overtime);

- (g) the influence of other ambient factors (e.g. heat) in enhancing the risk of exposure.

4.2.8. During the *third stage of the assessment*, the need for a programme for the measurement of airborne contaminants should be determined. It should be based on the information listed in paragraphs 4.2.2 to 4.2.6 above. It may also be preceded by simple qualitative tests such as the use of smoke tubes to determine ventilation characteristics, and the use of dust lamps for dust emissions. Such a programme is required to:

- (a) determine the extent of exposure of workers; and/or
- (b) check the effectiveness of engineering control measures.

4.2.9. The monitoring of airborne contaminants should be performed only by persons technically competent to:

- (a) determine the compatibility of sampling equipment with available analytical methods and validate the results;
- (b) interpret the results of monitoring with due regard to information obtained through the provisions in paragraphs 4.2.2 to 4.2.6 above, and with reference to exposure limits or other criteria determined by the competent authority.

4.2.10. The employer should:

- (a) arrange for regular inspection, maintenance and proper calibration of monitoring equipment;
- (b) review the assessment as specified in section 3.2 of this code.

4.2.11. Employers should keep dated records of measurements of airborne contaminants by technique and type (e.g. static, personal), including data on plant location, work area, work processes, nature of hazardous substances, names and lists of exposed workers and control measures in place. Such records should be kept for a period to be determined by the competent authority.

4.3. Prevention and control

4.3.1. Where the assessment of hazards or risks shows that control measures are inadequate or likely to become inadequate, risks should be:

- (a) eliminated by ceasing to use such hazardous substances or replacing them with less hazardous substances or modified processes;
- (b) minimized by designing and implementing a programme of action;
- (c) reduced by minimizing the use of toxic substances, where feasible.

4.3.2. Control measures for implementing such a programme could include any combination of the following:

- (a) good design and installation practice:
 - (i) totally enclosed process and handling systems;

Ambient factors in the workplace

- (ii) segregation of the hazardous process from the operators or from other processes;
 - (iii) plants, processes or work systems which minimize generation of, or suppress or contain hazardous dusts, fumes, etc., and which limit the area of contamination in the event of spills and leaks;
 - (iv) partial enclosure, with local exhaust ventilation;
 - (v) local exhaust ventilation;
 - (vi) sufficient general ventilation;
- (b) work systems and practices:
- (i) reduction of the numbers of workers exposed and exclusion of non-essential access;
 - (ii) reduction in the period of exposure of workers;
 - (iii) regular cleaning of contaminated walls, surfaces, etc.;
 - (iv) use and proper maintenance of engineering control measures;
 - (v) provision of means for safe storage and disposal of substances hazardous to health;
- (c) personal protection:
- (i) where the above measures do not suffice, suitable personal protective equipment should be provided until such time as the risk is eliminated or minimized to a level that would not pose a threat to health;
 - (ii) prohibition of eating, chewing, drinking and smoking in contaminated areas;
 - (iii) provision of adequate facilities for washing and changing and for storage of clothing (everyday clothing separated from work clothing), including arrangements for laundering contaminated clothing;
 - (iv) use of signs and notices;
 - (v) adequate arrangements in the event of an emergency.

4.3.3. With regard to control measures for hazardous chemicals in respect of storage, transport, disposal and treatment, the provisions laid down in the ILO code of practice *Safety in the use of chemicals at work* (Geneva, 1993) should apply, to the extent practicable with due regard to their flammability, reactivity and explosivity.

4.3.4. Additional precautions should be taken by the employer to protect the workers against risks to safety and health presented by those hazardous substances as may be specified by the competent authorities or in the ILO Conventions, Recommendations, codes of practice and guides and other standards issued by international organizations and other bodies (see section 4 of the annex).

4.4. Health surveillance

4.4.1. The provisions of section 3.5 of this code concerning health surveillance, the use of its results and record keeping should apply.

4.4.2. Exposure to the following types of hazardous substances may require appropriate health surveillance:

- (a) substances (dusts, fibres, solids, liquids, fumes, gases) that have a recognized systemic toxicity (i.e. an insidious poisonous effect);
- (b) substances known to cause chronic effects (e.g. occupational asthma);
- (c) substances known to be sensitizers, irritants or allergens;
- (d) substances that are known or suspected carcinogens, teratogens, mutagens or harmful to reproductive health reprotoxic substances;
- (e) other substances likely to have adverse health effects under particular work conditions or in case of fluctuations in ambient conditions.

4.4.3. In the case of exposure of workers to specific hazards, health surveillance should include biological monitoring for the early detection of the effects on health when:

- (a) a valid and generally accepted reference method exists;
- (b) it may be used to identify workers who need detailed medical examination (subject to the individual worker's consent);
- (c) it may be necessary to detect exposure levels and early biological effects and responses.

4.5. Training and information

4.5.1. Employers should ensure that workers have sufficient, specific and systematic training and information on:

- (a) the nature and degree of hazards and risks from hazardous substances which may occur, particularly in the case of an emergency;
- (b) the protection of their safety and health and that of others from hazardous substances which may be present, in particular by using correct and prescribed methods for the handling, storage and transport of hazardous substances, and waste disposal;
- (c) the correct and effective use of control and protection measures and of personal protective equipment.

This information should also be transmitted, where appropriate, to subcontractors and their workers.

4.5.2. Employers should ensure that special provisions for training and information are applied for newly recruited workers and for illiterate workers or foreign workers who may encounter language difficulties.

4.5.3. Employers should inform workers and their representatives, as appropriate, of the results of workplace assessments and of their health surveillance in relation to

Ambient factors in the workplace

risks caused by exposure to hazardous substances, and in particular those workers who have specific needs for protection related to their health condition.

4.5.4. Employers should ensure that their relevant managerial staff 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 emergencies.

4.5.5. In accordance with the provisions of the Chemicals Convention, 1990 (No. 170), and the ILO code of practice *Safety in the use of chemicals at work* (Geneva, 1993), the workers concerned and their representatives should be given information:

- (a) on the nature of chemicals used at work, the hazardous properties and precautionary measures to be taken;
 - (b) in the form of labels and markings, and set out in chemical safety data sheets;
- in forms and languages which they easily understand.

5. Ionizing radiation

5.1. Scope and principles

5.1.1. This chapter gives specific information on ionizing radiation to help employers, workers and competent authorities apply the general principles in Chapters 2 and 3. This chapter applies to workplaces where workers may be occupationally exposed to ionizing radiation.

5.1.2. The Radiation Protection Convention (No. 115), and Recommendation (No. 114), 1960, lay down basic principles and establish a fundamental framework for radiation protection of workers.

5.1.3. Detailed guidance on ionizing radiation is given in the *International basic safety standards for protection against ionizing radiation and for the safety of radiation sources* (jointly sponsored by the FAO, IAEA, ILO, OECD/NEA, PAHO and WHO), hereinafter referred to as the “*Basic safety standards*”; and the ILO code of practice *Radiation protection of workers (ionizing radiations)* (Geneva, 1987).

5.1.4. Employers should, with the cooperation of the competent authorities and workers’ organizations, consider the results of safety research and development, taking the necessary steps for practical implementation, as appropriate, for the optimization of the radiation protection of workers, categories of workers and the public.

5.1.5. The responsibilities of the competent authority (or authorities) concerned with radiation protection should include:

- (a) the formulation of the necessary criteria, standards and regulations for radiation protection, in consultation with the representative organizations of employers and workers concerned;
- (b) the establishment of a system for notification, registration or licensing as required in the *Basic safety standards*;
- (c) the provision of general guidance necessary for the implementation of the requirements;
- (d) the establishment of a system of inspection to ensure that the measures taken are in compliance with the relevant requirements.

5.1.6. The responsibilities of the employers (and registrants¹ and licensees,² as applicable) (hereinafter referred to as “management”) should include:

- (a) the establishment of a policy for the protection of the health and safety of workers, comprising appropriate measures, during planning, operation and

¹ An applicant who is granted registration of a practice or source and has recognized rights and duties for such a practice or source, particularly in relation to protection and safety.

² The holder of a current licence granted for a practice or source has recognized rights and duties for the practice or source, particularly in relation to protection and safety.

Ambient factors in the workplace

decommissioning, to prevent any unnecessary exposure in the installations under their control;

- (b) the restriction of occupational exposures resulting from justified practices so that they are as low as can be reasonably achieved, economic and social factors being taken into account, and within the constraints of occupational dose limits;
- (c) the provision of facilities, equipment and services for protection and safety, including health surveillance and health services as well as protective devices and monitoring equipment.

5.1.7. Workers should follow rules and procedures for protection and safety as specified by management, including:

- (a) the proper use of monitoring devices and protective equipment and clothing;
- (b) cooperation with the employer with respect to protection and safety and the operation of radiological health surveillance and dose assessment and training programmes;
- (c) providing the employer with any information on their past and current work and health status that relates to radiation exposure and is therefore necessary to ensure effective protection and safety for themselves and others.

5.1.8. Female workers who reveal their pregnancy should not be subject to unwarranted discrimination, for which there should be recourse in national laws and practice.

5.1.9. The competent authority should make arrangements to protect the health of itinerant workers in regard to radiation safety, so that the established radiation exposure limits are not exceeded.

5.2. Assessment

5.2.1. A prior radiological evaluation of hazards and risks and prevention and control measures should, in consultation with workers and/or their representatives, be the first step in establishing a radiation protection programme (see section 3.1 of this code). The degree of effort, formalities and details of the evaluation and the scrutiny to which it is subjected should be in line with the magnitude of normal and potential exposures and the probability of the latter.

5.2.2. The prior radiological evaluation should include for all aspects of operation:

- (a) an identification of the sources of normal and reasonably foreseeable potential exposures;
- (b) a realistic estimate of the doses;
- (c) an identification of the radiological protection measures needed to meet the optimization principle.

5.2.3. Prior evaluation should be used to help determine what can be achieved at the design stage of installation to establish satisfactory working conditions through the use of engineered features, including the provision of shielding, containment, ventilation and interlocks. These considerations should aim to minimize the need for relying on administrative controls and personal protective equipment for protection and safety during normal operation.

5.2.4. Where authorization by registration or licensing is required, the legal person¹ applying for the authorization should make an assessment of the nature, magnitude and likelihood of the exposure and, if necessary, make a safety assessment. Such a safety assessment should contribute to the design of the radiation protection programme. The safety assessment should include, as appropriate, a systematic critical review of:

- (a) the nature and magnitude of potential exposures and the likelihood of their occurrence;
- (b) the limits and technical conditions for operation of the source;
- (c) the ways in which structures, systems, components and procedures related to radiation protection or safety might fail, singly or in combination, or otherwise lead to potential exposures, and the possible consequences of such failures;
- (d) the ways in which changes in the environment could affect protection or safety;
- (e) the ways in which operating procedures related to protection or safety might be erroneous, and the consequences of such errors;
- (f) the protection and safety implications of any proposed modifications.

5.2.5. The safety assessment should be documented and reviewed. Additional reviews should be performed as necessary to ensure that the technical specifications or conditions of use continue to be met whenever:

- (a) significant modifications to a source or its associated plant or its operating or maintenance procedures are envisaged;
- (b) operating experience or other information about accidents, failures, errors or other events that could lead to potential exposures indicates that the current assessment might be invalid;
- (c) any significant changes in activities, or any relevant changes in guidelines or standards are envisaged or have been made.

¹ The term “legal person” is defined in the glossary of the *Basic safety standards* as: “Any organization, corporation, partnership, firm, association, trust, estate, public or private institution, group, political or administrative entity or other persons designated in accordance with national legislation, who or which has responsibility and authority for any action taken under these standards”.

5.3. Prevention and control

5.3.1. The radiation protection measures should be commensurate with the nature and extent of the risks. The implementation of the optimization principle should be the driving force behind the establishment and implementation of radiation protection programmes by the employer, including in many cases measures to prevent or reduce potential exposures and mitigate the consequences of accidents.

5.3.2. Whatever the situation, the radiation protection programme should provide for, inter alia, with an appropriate level of detail:

- (a) the written assignment of responsibilities to different management levels, including corresponding organizational arrangements and, if applicable, the allocation of the respective responsibilities between employers and the registrant or licensee concerning occupational radiation protection and safety;
- (b) the designation of controlled or supervised areas (see paragraph 5.3.3 below);
- (c) the local rules for workers and the supervision of work;
- (d) the arrangements for monitoring workers and the workplace;
- (e) the system for recording and reporting all the relevant information related to the control of exposures, the decisions regarding measures for occupational radiation protection and safety, and the monitoring of individuals;
- (f) the education, training and information programme (see section 5.5 of this code);
- (g) the methods for reviewing and auditing periodically the performance of the radiation protection programme;
- (h) health surveillance (see section 5.4 of this code);
- (i) the requirements for the assurance of quality and process improvement;
- (j) the appointment of a radiation protection officer, when required by the competent authority, to oversee the application of the regulatory requirements.

5.3.3. Management, in accordance with the requirements of the *Basic safety standards* referred to in paragraph 5.1.3 of this code, should designate as a:

- (a) *controlled area* any area in which specific protective measures or safety provisions are or could be required for:
 - (i) controlling access and normal exposures or preventing the spread of radioactive contamination during normal working conditions;
 - (ii) preventing or limiting the extent of potential exposures;
- (b) *supervised area* any area not already designated as a controlled area but where occupational exposure conditions need to be kept under review.

5.3.4. Management, in consultation with workers and/or their representatives, if appropriate, should:

- (a) establish in writing local rules providing for the general organizational structures and the special procedures to be followed in controlled areas;
- (b) include in the local rules the values of relevant reference or authorized levels, and the procedure to be followed in the event that any such levels are exceeded;
- (c) ensure that the rules, procedures, protective measures and safety provisions are known to and observed by workers and other persons to whom they apply;
- (d) ensure that any work involving occupational exposure is adequately supervised.

5.3.5. When engineering and operational control measures are not sufficient to provide an optimized level of protection for the tasks to be performed, management should ensure that workers are:

- (a) provided with suitable, adequate and well-maintained and tested personal protective equipment;
- (b) given adequate instruction in its proper use and maintenance.

5.3.6. Management should assess the occupational exposure of workers:

- (a) by individual monitoring, where appropriate. Its nature, frequency and precision should be determined based on the magnitude and possible fluctuations of exposure levels and the likelihood and magnitude of potential exposures;
- (b) by monitoring of the workplace. Its nature and frequency should depend on the ambient radiological conditions of the workplace and the fluctuations thereof and be sufficient to assess exposure and review the classification of controlled areas and supervised areas. A programme for the monitoring of the workplace under the supervision of a radiation protection officer, if so required by the competent authority, should be established, maintained and kept under review.

5.3.7. Management should:

- (a) maintain and retain up-to-date exposure records in accordance with national laws and internationally recognized practice for each worker for whom assessment of occupational exposure is required;
- (b) keep up-to-date records of the findings of the workplace monitoring programme and make them available to workers and/or their representatives.

5.3.8. As required by the *Basic safety standards*, management should establish a quality assurance programme, the nature and extent of which should be commensurate with the magnitude and the likelihood of potential exposures from the source.

5.3.9. The radiation protection programme should be reviewed on a regular basis. Audits and/or reviews should be scheduled on the basis of the status and importance of the activity. Management should make arrangements for an independent assessment of the implementation of the radiation protection programme in order to identify and correct administrative and management problems in the achievement of its objectives.

Ambient factors in the workplace

5.4. Health surveillance

5.4.1. Management should make arrangements for appropriate health surveillance in accordance with the rules established by the competent authority.

5.4.2. If one or more workers are to be engaged in work that involves or could involve exposure from a source that is not under the control of the employer, the person (registrant or licensee) responsible for the source should make any special arrangements for health surveillance with the employer, as specified by the competent authority.

5.5. Training and information

5.5.1. As part of the radiation protection programme, management should establish an education, training and information programme in order to ensure that:

- (a) all workers receive adequate information on:
 - (i) the health risks due to their occupational exposure, whether normal exposure or potential exposure, or in emergency situations;
 - (ii) the significance for protection and safety of their actions;
- (b) all workers receive adequate instructions and training on radiation protection and safety;
- (c) information and appropriate training are provided to persons with assigned responsibilities in the radiation protection programme;
- (d) appropriate management receive training on the basic principles of radiological protection, their main responsibility regarding radiation risk management and the principal elements of the radiation protection programme;
- (e) appropriate information is provided to female workers who are likely to enter controlled or supervised areas on the risk to the embryo or foetus due to exposure and on the importance for a female worker of notifying her employer as soon as she suspects her pregnancy;
- (f) the conditions for promoting consultation and cooperation with workers and a culture of safety are created;
- (g) records of the training provided to individual workers are kept.

6. Electric and magnetic fields

6.1. Scope

6.1.1. This chapter gives specific information to help employers, workers and competent authorities apply the general principles in Chapters 2 and 3. It applies to activities where workers are exposed to electric and magnetic fields, including static fields (0 Hz), extremely low frequency (ELF) fields (up to 300 Hz) – which include electric and magnetic fields at frequencies between 50 and 60 Hz (also called power frequencies) – and radiofrequency (RF) fields (from 300 Hz to 300 GHz).

6.1.2. In the application of the provisions of this code, the detailed guidance given in the following practical guides published in the ILO Occupational Safety and Health Series should be taken into consideration: No. 69 on *Protection of workers from power frequency electric and magnetic fields* (Geneva, 1994); No. 70 on *Visual display units: Radiation protection guidance* (Geneva, 1994); and No. 71 on *Safety in the use of radiofrequency dielectric heaters and sealers* (Geneva, 1998).

6.2. Assessment

6.2.1. For the prevention of adverse effects of electric and magnetic fields on workers, employers should:

- (a) identify the sources of electric and magnetic fields and the equipment and activities which could give rise to exposure at or near prescribed national or internationally recognized standards;
- (b) obtain information on the exposure of workers:
 - (i) where they are likely to be exposed to significant electric or magnetic fields, including in the case of workers who may move from site to site;
 - (ii) by comparison with other similar workplaces and equipment;
 - (iii) from the occupational health service or the competent authority;
- (c) seek advice from suppliers about the fields produced and the recommended precautions, and make this information a factor to be considered in the purchase of new equipment;
- (d) if this advice is incomplete or otherwise of doubtful value, arrange for measurements by a technically competent person, to be carried out in accordance with current national and international knowledge.

6.2.2. Employers should assess the hazard or risk by:

- (a) reference to national exposure limits and to internationally recognized standards (see section 6 of the annex) in the absence of national standards;

Ambient factors in the workplace

- (b) comparing actual exposure levels with exposure limits following measurements by a technically competent person, carried out in accordance with current national and international knowledge.

6.2.3. Employers should conduct assessments:

- (a) before routine operations begin, for all new installations capable of producing electric or magnetic fields exceeding the recommended exposure limits;
- (b) when any malfunction is suspected that may significantly affect field strengths;
- (c) following any repairs or changes in working conditions, protective shielding and barriers that may affect the exposure levels;
- (d) at appropriate intervals of installations capable of exposing personnel in excess of the recommended exposure limits.

6.2.4. Employers should keep records of all formal field strength survey measurements and their evaluation; such records should include a review of all known incidents and their attributed causes.

6.2.5. In assessing the hazard and risk, the employer should take account of the need to prevent cardiac accidents which may result from exposure of workers with pacemakers or similar medical implants to electric and magnetic fields, as well as the special needs of workers for protection in relation to their health condition, for example in the case of pregnant women.

6.3. Prevention and control

6.3.1. Employers should ensure protection from electric and magnetic field exposure by:

- (a) preventing dangerous exposure;
- (b) the practice of caution and prudent avoidance;
- (c) using appropriate techniques to minimize undue exposure to high-intensity fields.

In adopting appropriate techniques, employers should seek the advice of a technically competent person or service.

6.3.2. In the case of excessive, avoidable or unintentional radiation or leakage, employers should give priority to the minimization of unwanted emission of electric and magnetic fields from the source itself by shielding and absorbing with appropriate materials and design.

6.3.3. Employers should ensure that high radiofrequency (RF) aerials are designed and installed to direct the radiation away from any personnel and take due care to prevent the wave front from being reflected by material or other structures.

6.3.4. When workers are exposed to deliberate radiation sources such as antennas for broadcasting and telecommunication and the radiation cannot be suppressed, they should wear appropriate personal protection suits to reduce the coupling with the electromagnetic field, and the absorption of energy by organs or tissues of the body.

6.3.5. If shielding is not a practicable method of reducing the intensity of the fields, employers should limit:

- (a) access of personnel to areas where an exposure limit is or may be exceeded;
- (b) the exposure of workers present in these areas;
- (c) access of personnel fitted with cardiac pacemakers and similar medical implants, where there is significant exposure to electric or magnetic fields;

and ensure that:

- (d) sources are enclosed to prevent the spread of an electric field, controlled access is established, and the duration of exposure is reduced;
- (e) electric and magnetic field sources are positioned as far as practicable from areas to which workers normally have access;
- (f) the immediate vicinity of unmanned high-field sources is fenced off and warning signs and labels are posted;
- (g) exposure in uncontrolled areas does not exceed the general public limits;
- (h) satisfactory interlock systems are provided to prevent entry while the field is “live” and high-risk fields are present;
- (i) workers are protected against electric shock;
- (j) magnetic fields that may be strong enough to affect cardiac pacemakers or similar medical implants are clearly marked.

6.4. Health surveillance

6.4.1. Health surveillance of workers exposed to electric and magnetic fields should be carried out in accordance with the requirements given in the practical guides mentioned in paragraph 6.1.2 above, and might include:

- (a) assessment of the health status of the worker before starting work with electric and magnetic field exposure (pre-employment or pre-assignment), during the exposure period and at the end of occupational exposure (at no financial cost to workers), with a view to detecting contraindications and ensuring protection of the worker and the safe use of electric and magnetic fields;
- (b) detection and early prevention and treatment of any adverse effects caused by exposure;
- (c) collection of precise individual data on exposure to electric and magnetic field and adequate health records that can be used in future epidemiological studies.

Ambient factors in the workplace

6.5. Training and information

6.5.1. Employers should ensure that workers exposed to significant electric or magnetic fields are provided with training, instructions and information on:

- (a) normal safe operating practices and the procedures to be followed in the event of malfunction of the devices, or in an emergency;
- (b) the hazards associated with operating the specific devices assigned to them and, in particular, the importance of any interlock system and dangers associated with defeating such systems;
- (c) the effect of magnetic fields on cardiac pacemakers and similar medical implants;
- (d) the use of personal protective equipment;
- (e) effects that may occur after exposure to electric or magnetic fields has ceased.

7. Optical radiation

7.1. Scope

7.1.1. This chapter gives specific information to help employers, workers and competent authorities apply the general principles in Chapters 2 and 3. It applies to workplaces where there is hazardous exposure to optical radiation – ultraviolet (UV), visible light and infra-red (IR) – as a result of work activities, or where lasers are being used. Detailed guidance on specific issues given in *The use of lasers in the workplace*, ILO Occupational Safety and Health Series No. 68 (Geneva, 1993); and *Visual display units: Radiation protection guidance*, ILO Occupational Safety and Health Series No. 70 (Geneva, 1994) should be taken into consideration in the application of the provisions of this code.

7.2. Assessment

7.2.1. Employers should assess equipment and activities likely to give rise to hazardous exposure to optical radiation. The assessment should include outdoor work which exposes workers to the sun.

7.2.2. Employers should seek information from the suppliers of equipment about expected hazardous emissions and precautions to be taken in installation, labelling and use. Where this is not practicable, employers should obtain information:

- (a) by comparison with other similar workplaces and equipment;
- (b) from the occupational health service or a competent body.

7.2.3. Employers should assess the hazard and risk:

- (a) by characterizing the level of hazard and risk including by comparing the real exposure levels with exposure limits following measurements by a technically competent person using appropriate and properly calibrated equipment, designed to assess hazard to health of UV, IR radiation or visible light, as applicable. Laser hazard evaluation should preferably be carried out by appointed laser safety officers;
- (b) by seeking advice from the competent authority about the exposure limits to be applied and measures for assessment;
- (c) from misuse or misunderstanding of safety precautions (such as violations of enclosures and of access restrictions).

7.2.4. Where class 3 or class 4 lasers (see section 7 of the annex) are to be used outdoors, employers should assess:

- (a) the maximum range for which the beam can be hazardous (this is likely to be limited only by effective absorption);

Ambient factors in the workplace

- (b) the risk of reflection from glass or other highly polished surfaces, including the risk of such material being brought near the beam (for example by motor vehicles being driven into the beam or into an area where a reflected or scattered beam may be present);
- (c) the risk of diffuse scattering, particularly for lasers in the visible or near infra-red range;
- (d) the stability of the laser mounting and the maximum deviation of the beam due to deliberate or accidental movement of the mounts;
- (e) ways in which workers and others might wander into the vicinity of the beam, and preventive measures to be applied;
- (f) the effectiveness of warning notices, notably for people with different reading or language abilities.

7.3. Prevention and control

7.3.1. Employers should take all safety precautions and prevention and control measures to reduce the risk of exposure to hazardous levels of optical radiation and to other associated hazards.

7.3.2. Where significant optical radiation exists, employers should ensure that:

- (a) tungsten-halogen lamps are only used with glass filters;
- (b) warning labels are in place;
- (c) other lighting devices likely to emit significant UV radiation are correctly positioned;
- (d) lamps and replacements are correctly stored to prevent damage to the safety features;
- (e) accidental replacement of conventional lamps with hazardous ones is prevented (for example the replacement of a conventional fluorescent tube with a germicidal lamp);
- (f) shields and enclosures are correctly replaced when lamps are changed;
- (g) other faults (for example inadequate shielding) are noticed and remedied.

7.3.3. In areas where lasers are used, employers should ensure that:

- (a) the lowest laser class (see section 7 of the annex) suitable for the application is used;
- (b) at time of purchase, any laser equipment is without hazard or risk, enclosed and properly labelled, where appropriate;
- (c) class 3 or class 4 lasers are:
 - (i) only used by authorized and properly trained workers;

- (ii) properly installed and enclosed and accessible only to authorized workers;
- (iii) used outdoors with due care, to ensure that the beam is absorbed at the end of its path; that access is controlled; and that reflective material is removed from the vicinity of the beam (see paragraph 7.2.4);
- (d) where enclosure neither of the systems nor the beam is practicable, a clearly designated controlled area is assigned with restricted access;
- (e) the use of optical instruments (such as lenses or telescopes which might accidentally focus the beam) is controlled;
- (f) laser set-up and alignment are only conducted in the presence of properly trained personnel with eye protection appropriate for the lasers in use.

7.3.4. Where lasers are used for diagnosis or surgery, employers should ensure that:

- (a) all personnel are properly trained concerning the hazards of lasers and the safety precautions to be taken against any risk or injury to the personnel and patients;
- (b) specialist equipment used is appropriate;
- (c) non-flammable products are used for anaesthesia.

7.3.5. Employers should give consideration to:

- (a) positioning and enclosure of laser beams (as they travel large distances without loss of strength);
- (b) the need to avoid reflection or scattering into occupied areas;
- (c) the use of screening material (such as plastic curtains) which appears opaque in visible light but is transparent to an infrared laser;
- (d) surfaces which diffusely scatter visible light (such as painted surfaces) but are highly reflective for an infra-red laser.

7.3.6. Employers should ensure that a key control system is operated for equipment with higher-class lasers and access is restricted to properly trained and supervised personnel.

7.3.7. Employers should:

- (a) provide specialized eye protection to workers at risk of exposure to lasers;
- (b) provide effective eye and skin protection to workers exposed to UV emissions, including welding helmets, and organize work patterns and worker location to ensure the protection of non-welders;
- (c) erect warning signs to prevent casual access to welding areas, high-level infra-red and laser zones;
- (d) where practicable, in the case of outdoor work:
 - (i) minimize exposure of workers to the sun by organizing the work so that it can be carried out in the shade;

Ambient factors in the workplace

- (ii) protect workers by appropriate clothing and personal protection, such as sunscreen ointment or lotions and eye protection, when necessary.

7.4. Health surveillance

7.4.1. Employers should arrange for appropriate health surveillance by occupational health personnel who should assess the possible need for examination, including ophthalmic and skin examination, for those exposed to significant levels of optical radiation and/or involved in work with lasers.

Health personnel should ascertain signs of photosensitization caused by combined exposure to UV radiation and the use of medicines, including inhalers, or lotions or ointments applied on the skin.

7.4.2. Employers should arrange for workers using class 3 or 4 lasers to receive:

- (a) pre- and post-assignment ophthalmic examinations;
- (b) an immediate ophthalmic examination after an apparent or suspected injurious ocular exposure, supplemented by a bio-physical examination of the circumstances under which the accident occurred.

7.5. Training and information

7.5.1. Employers should inform workers likely to be exposed to significant levels of optical radiation and/or involved in work with lasers:

- (a) about the hazards to health of optical radiation and the sources and activities that may pose a risk of exposure, especially about the need for protection against the effects of the sun;
- (b) of the importance in outdoor work of using any available shade and personal protection, where indicated, including protective clothing and sunscreen ointments and lotions;
- (c) of the serious risks to eyesight if proper protection is not used, for example in welding, laser operation and high-level IR radiation sources, such as furnaces;
- (d) about the serious limitations of blue lenses (used in steelworks and foundries to check the temperature of the melt) in providing eye protection;
- (e) performing maintenance and cleaning tasks of the function and correct maintenance of lamp shields and enclosures, instructing them to notify at once if protective shields are faulty;
- (f) that some perfumes and medicines can cause sensitization on exposure to UV radiation and that they may need to consult their physician.

7.5.2. Employers should ensure that:

- (a) all workers using lasers are properly trained in:

Optical radiation

- (i) the laser classification systems and the processes for which the lasers are used;
 - (ii) the correct use and maintenance of enclosures, key controls, other protective systems and required personal protective equipment;
- (b) workers not directly involved in the use of lasers understand:
- (i) the general nature of lasers and the rules for their use;
 - (ii) the meanings of warning notices and signs and of access restrictions;
- (c) the laser safety officer, if one is appointed, is:
- (i) familiar with the safety policy of the enterprise and involved in its implementation;
 - (ii) adequately trained in all the uses of lasers in the enterprise;
- (d) workers' representatives cooperate in providing training and information to the workers.

8. Heat and cold

8.1. Scope

8.1.1. This chapter gives additional and specific information to help employers, workers and competent authorities apply the general principles in Chapters 2 and 3. It applies to conditions in which:

- (a) temperatures and/or humidity are unusually high;
- (b) workers are exposed to high radiant heat;
- (c) high temperature and/or humidity occur in combination with protective clothing or high work rate;
- (d) temperatures are unusually low (e.g. in outdoor work during winter season, in cold storage work);
- (e) high wind speeds (>5 m/s) prevail with unusually low temperatures;
- (f) work with bare hands is carried out for extended periods of time at temperatures below 15 °C.

8.1.2. Workers should be allowed sufficient time to acclimatize to an extremely hot or cold environment, including major changes in climatic conditions.

8.1.3. This chapter does not deal with:

- (a) risk of injury from contact with very hot or cold surfaces, but where these exist the employer should take this risk into account in assessing control measures that are appropriate;
- (b) special measures required to protect against the effect of immersion in cold water, by diving or by accident.

8.2. Assessment

8.2.1. If workers are exposed for all or part of their tasks to any conditions listed in paragraph 8.1.1 above and the hazards and risks cannot be eliminated, employers should assess the hazard or risk to safety and health from the thermal conditions, and determine the controls necessary to remove such hazards or risks or to reduce them to the lowest practicable level.

8.2.2. The assessment for the thermal environment should take into account risks arising from working with hazardous substances in work situations such as:

- (a) the use of protective clothing against hazardous substances that may increase the risk from heat stress; and

- (b) a hot environment that makes respiratory protection uncomfortable and less likely to be used and necessitates restructuring of jobs in order to reduce the risks, for example by:
 - (i) minimizing exposure to hazardous substances so that there is less need for protective clothing;
 - (ii) changing the tasks so that work rates in hot conditions can be reduced.

8.2.3. In assessing the hazard and risk, employers should:

- (a) make comparisons with other similar workplaces where measurements have been made;
- (b) where this is not practicable, arrange for measurements to be performed by a technically competent person, using appropriate and properly calibrated equipment;
- (c) seek the advice of the occupational health service or a competent body about exposure standards to be applied (see also section 8 of the annex);
- (d) bear in mind that the quality of fine work done by hand is adversely affected by cold temperatures.

8.2.4. Measurements of thermal conditions should take account of:

- (a) all stages of work cycles and the range of temperature and humidity under which the tasks are performed;
- (b) the range of clothing worn during the tasks;
- (c) major changes in physical activity level (metabolic heat production);
- (d) occasional tasks such as cleaning and maintenance of hot equipment and cold areas, and renewal of hot or cold insulation.

8.2.5. The measurement survey should be structured so as to identify the sources of any problem, and the tasks in which it occurs. If the risk assessment shows that thermal conditions are outside the ranges recommended by the standards referred to in section 8 of the annex, the employer should assess control options and take effective control measures.

8.2.6. The plan for monitoring (see paragraph 3.1.6 above) should take account of variations in thermal conditions, especially seasonal variations where these are significant.

8.3. Prevention and control in hot environments

8.3.1. Where assessment shows that the workers may be at risk from heat stress, employers should, if practicable, eliminate the need for work in hot conditions or, if elimination is not practicable, take measures to reduce the thermal load from the environment.

8.3.2. Where the workers are at risk from exposure to radiant heat by working near hot surfaces:

Ambient factors in the workplace

- (a) the employer may increase the distance between the equipment (taking care not to do so to the detriment of other workplaces) and the exposed workers;
- (b) when this is not practicable, the employer should:
 - (i) reduce the temperature of the surface by changing plant operating temperatures, insulating the surfaces, or reducing the emissivity of the surface; or
 - (ii) change plant temperature.

8.3.3. Where surface temperature reduction is not practicable, employers should consider:

- (a) the use of radiation barriers (of low conductivity and high emissivity) between the surface and the workplace and maintaining them in a clean state;
- (b) water-cooling the hot surfaces, where practicable;
- (c) the use of portable reflective shielding;
- (d) arranging for remote control operations.

8.3.4. Where the assessment shows that health or discomfort conditions arise from increased air temperature, the employer should implement means to reduce air temperature, such as a ventilation system. The design should take into account seasonal and sudden temperature changes in make-up air brought from outside. If the air temperature is below about 36 °C, increasing air movement (for example by fans) will cool the workers; above that temperature it will heat them further.

8.3.5. It may be possible to provide cool air to the worker's location where this is sufficiently static, but this should be done carefully to avoid draughts.

8.3.6. The air may be cooled by evaporation, for example by water sprays, in addition to or instead of ventilation. The design of such a system should first be checked by a technically competent person to ensure that, in the circumstances of use, the increase in humidity does not counteract the effect of the temperature decrease on the working environment.

8.3.7. Employers should take particular care with ventilation design where work is undertaken in enclosed spaces or areas. When fail-safe systems are not in operation, there should be adequate supervision of exposed workers to ensure that they can be removed from danger.

8.3.8. Where part of the risk arises from the metabolic heat produced during work, and other methods of eliminating the risk are impracticable, employers should arrange a work-rest cycle for exposed workers, either in the workplace or in a cooler rest-room. The rest periods should be as prescribed by the competent authority and/or sufficient to allow the worker to recover (see paragraph 8.2 of the annex). Employers should ensure that appropriate mechanical aids are available to reduce workloads and that tasks performed in hot environments are well designed ergonomically to minimize physical stress.

8.3.9. Where other methods of controlling thermal risk, including a work-rest regime, are not practicable, employers should provide protective clothing. In the selection of such clothing, consideration may be given to the following:

- (a) reflective clothing where heat gain is mostly by radiation;
- (b) insulated clothing with reflective surfaces during simultaneous exposure to high radiant heat and hot air (allowing freedom of movement to perform tasks);
- (c) air-, water- or ice-cooled clothing in other instances and as a possible complement to (a) and (b) above.

8.3.10. Where failure of the protective clothing could expose the worker to extremes of temperature, the clothing should be carefully selected and its use monitored by a technically competent person, taking account of the environmental conditions. A system should be installed to ensure that any failure of the cooling system is immediately detected and the worker removed from the environment.

8.3.11. For hydration maintenance, employers should make water at low salt concentration or dilute flavoured drinks readily available to workers, and should encourage them to drink at least hourly, by providing a close source or arranging for drinks to be brought to the workers. Drinks at 15 to 20 °C are preferable to iced drinks. Alcohol, caffeine, carbonated drinks or drinks with a high salt or sugar content are unsuitable, as are drinking fountains because they are too difficult to drink from in sufficient volume.

8.3.12. Where a residual risk of heat stress remains even after all the control measures have been taken, workers should be adequately supervised so that they can be withdrawn from the hot conditions if symptoms occur. Employers should ensure that first-aid facilities and staff trained in the use of such facilities are available.

8.4. Prevention and control in cold environments

8.4.1. Where the assessment shows that the workers may be at risk from exposure to cold, the employers should, if practicable, eliminate the need for work in cold conditions (for example by rescheduling work to be performed in a warmer season, or by moving the work from outdoors to indoors, or separating the cold parts of a process from the workers, as far as practicable). If elimination of such work is impracticable, employers should introduce other control measures to reduce risk from cold conditions.

8.4.2. Where the work is done outdoors, or the temperature at the workplace depends on outdoor temperature, employers should take into account present and forecast weather conditions in scheduling work, and monitor conditions while long-duration work is in progress.

Ambient factors in the workplace

8.4.3. Employers should ensure that workers are not positioned near very cold surfaces or, if this cannot be avoided, that the workers are protected by radiation shields. For standing tasks, the floor should, where practicable, have an insulating surface.

8.4.4. Where work is conducted at low air temperatures, employers should ensure that the velocity of air movement around the workers is minimized (to the extent consistent with providing the workers with sufficient fresh air).

8.4.5. Protection should take into account the air movement experienced when riding on an open vehicle (such as a fork-lift truck in a cold store). For outdoor work, employers should, as far as practicable, provide a workplace protected from wind, rain and snow. When high wind speed is prevailing, the special cooling risk (wind chill) should be considered and appropriate protective clothing, headgear and face masks should be made available.

8.4.6. Where work is carried out at unusually low temperatures:

- (a) employers should implement work-rest cycles with warm shelters for recovery when:
 - (i) work is likely to last for some time;
 - (ii) the temperature and wind speed are likely to vary;
 - (iii) workers are experiencing or showing symptoms of discomfort;
- (b) work scheduling should allow for the extra time taken by tasks in the cold, and the need for adequate drink and food;
- (c) where practicable, work rates should be designed to avoid heavy sweating, but if this does occur, employers should ensure that dry replacement clothing is available with warm changing facilities.

8.4.7. Where it is not practicable to eliminate the need for work in cold environments, employers should ensure the provision of:

- (a) adequate protective clothing properly designed and fitted for protection against cold;
- (b) adequate facilities for changing;
- (c) arrangements for cleaning such clothing and drying clothing and footwear between shifts;
- (d) headgear which is comfortable to wear, wind-proof (if appropriate), with adequate protection for ears and neck, and compatible with safety equipment.

8.4.8. Workers in the cold will often need to urinate more frequently, and employers should ensure that suitable arrangements are available, where feasible, and that the design of protective clothing allows easy urination.

8.4.9. Workers should be consulted and should cooperate in the choice, fitting and wearing of the protective clothing.

8.4.10. Suitable protection should be given to the hands and fingers, particularly where dexterity is needed, as well as other exposed parts of the body. Employers should provide:

- (a) facilities for warming the hands, for example by warm air, where appropriate;
- (b) tools with insulated handles, especially in temperatures below freezing point;
- (c) measures to ensure that the bare hand does not touch surfaces below $-7\text{ }^{\circ}\text{C}$ (workplace design or protective clothing);
- (d) measures to ensure that bare skin does not touch liquids below $4\text{ }^{\circ}\text{C}$;
- (e) appropriate measures to be taken in the event of insulating clothing getting wet;
- (f) face and eye protection, as appropriate, for outdoor work and working in snow (e.g. safety goggles against glare).

8.4.11. As there is danger of dehydration in cold environments, particularly when these are also dry, employers should make water or dilute flavoured drinks readily available to workers, and should encourage them to drink, by providing a close source or arranging for drinks to be brought to the workers. Alcohol, caffeine, carbonated drinks or drinks with a high salt or sugar content are unsuitable, as are drinking fountains because they are too difficult to drink from in sufficient volume.

8.4.12. Where a residual risk of hypothermia is unavoidable, even after all the control measures have been taken, and particularly below $-12\text{ }^{\circ}\text{C}$, workers should be adequately supervised so that they can be withdrawn from the cold if symptoms occur, bearing in mind that confusion is a symptom of hypothermia and therefore workers in an emergency may not rescue themselves. Workers at risk should not be left on their own long enough for a dangerous condition to develop. Particular care should be taken to design tasks and workplaces in cold environments to minimize the risk of accident. Employers should ensure that first-aid facilities as well as staff trained in the use of such facilities are available.

8.5. Health surveillance

8.5.1. In cases where control is provided by work-rest systems (see paragraphs 8.3.8 and 8.4.6 above) or protective clothing, workers should be examined by qualified occupational health personnel who should determine:

- (a) their fitness for the conditions of work;
- (b) any limitations that should be applied to their work;
- (c) the programme of training and information of workers;
- (d) the measures for providing such training and information;
- (e) any pre-existing conditions which might affect their tolerance to heat or cold (such as heart disease, overweight or some skin diseases); and

Ambient factors in the workplace

- (f) measures to minimize risks among vulnerable groups (such as older workers).

8.6. Training and information

8.6.1. Workers exposed to heat or cold and their supervisors should be trained:

- (a) to recognize symptoms which may lead to heat stress or hypothermia, in themselves or others, and the steps to be taken to prevent onset and/or emergencies;
- (b) in the use of rescue and first-aid measures; and
- (c) about action to be taken in the event of increased risks of accidents because of high and low temperatures.

8.6.2. Workers should be advised of:

- (a) the importance of physical fitness for work in hot or cold environments;
- (b) the importance of drinking sufficient quantities of liquid and the dietary requirements providing intake of salt and potassium and other elements that are depleted due to sweating;
- (c) effects of drugs which can reduce their tolerance to thermal extremes.

9. Noise

9.1. Scope

9.1.1. This chapter gives additional and specific information to help employers, workers and competent authorities apply the general principles in Chapters 2 and 3.

9.1.2. The information on the assessment of noise exposure and protective and preventive measures contained in this code and provided for in the Working Environment (Air Pollution, Noise and Vibration) Convention (No. 148), and Recommendation (No. 156), 1977, and the ILO code of practice *Protection of workers against noise and vibration in the working environment* (Geneva, 1984) should apply. Further detailed information can be found in section 9 of the annex.

9.1.3. In addition, for the prediction of the amount of hearing loss expected to occur as a function of noise exposure level and duration, age and sex, when no national provisions are available, then the international consensus standard ISO 1999, *Acoustics: Determination of occupational noise exposure and estimate of noise-induced hearing impairment* (1990), should apply.

9.1.4. This chapter does not deal with exposure to either infra-sound or ultrasound. Other national or internationally recognized standards should be consulted for an assessment of the hazard or risk from exposure to those types of sound.

9.2. Assessment

9.2.1. The level of noise and/or duration of exposure should not exceed the limits established by the competent authority or other internationally recognized standards. The assessment should, as appropriate, consider:

- (a) the risk of hearing impairment;
- (b) the degree of interference to speech communications essential for safety purposes;
- (c) the risk of nervous fatigue, with due consideration to the mental and physical workload and other non-auditory hazards or effects.

9.2.2. For the prevention of adverse effects of noise on workers, employers should:

- (a) identify the sources of noise and the tasks which give rise to exposure;
- (b) seek the advice of the competent authority and/or the occupational health service about exposure limits and other standards to be applied;
- (c) seek the advice of the supplier of processes and equipment about expected noise emission;

Ambient factors in the workplace

- (d) if this advice is incomplete or otherwise of doubtful value, arrange for measurements by persons competent to undertake these in accordance with current national and/or internationally recognized standards.

9.2.3. Noise measurements should be used to:

- (a) quantify the level and duration of exposure of workers and compare it with exposure limits as established by the competent authority or internationally recognized standards to be applied (see also section 9 of the annex);
- (b) identify and characterize the sources of noise and the exposed workers;
- (c) create a noise map for the determination of risk areas;
- (d) assess the need both for engineering noise prevention and control and for other appropriate measures and for their effective implementation;
- (e) evaluate the effectiveness of existing noise prevention and control measures.

9.2.4. Based on the assessment of the exposure to noise in the working environment, the employer should establish a noise prevention programme with the aim of eliminating the hazard or risk or reducing them to the lowest practicable level by all appropriate means.

9.3. Prevention and control

9.3.1. In the case of new processes and equipment, employers should, where feasible:

- (a) specify low noise output of the processes and equipment as a condition of purchase alongside production-related specifications;
- (b) arrange the workplace layout to minimize noise exposure to the workers by:
 - (i) placing noisier machines together away from quieter areas;
 - (ii) minimizing human intervention in the noisy areas.

9.3.2. In the case of existing processes and equipment, employers should first consider whether the noisy process is necessary at all, or whether it could be carried out in another way without generating noise. For the replacing process, however, the inherent hazards should be identified before its use (in the case of replacing riveting by welding, for example, risks from hazardous chemicals and/or UV light should be expected). If elimination of the noisy process as a whole is not practicable, employers should consider replacing its noisy parts with quieter alternatives.

9.3.3. If the elimination of noisy processes and equipment as a whole is impracticable, their individual sources should be separated out and their relative contribution to the overall sound pressure level identified. Once the causes or sources of noise are identified, the first step in the noise control process should attempt to control at source:

- (a) noise generated by impact: eliminating the impact, reducing its velocity, changing from metal to plastic materials, or cushioning or coating one or both of the surfaces;
- (b) noise from moving parts: dynamic balancing of rotating parts, widening of gaps where moving parts just miss obstructions, and arranging for rotating movements rather than reciprocating ones;
- (c) noise originating in fluid flow: reducing the velocity by widening the channel and the turbulence by eliminating obstructions, avoidance of unnecessary air-jets, fitting of silencers to exhausts;
- (d) periodic maintenance and repair, such as repair of faulty bearings, broken gear teeth, blunt cutting tools, and maintenance of belts and fans and other moving parts;
- (e) minimizing, if possible, the time during which the noisy equipment is run.

Many of these control measures will also be effective in reducing vibration.

9.3.4. If prevention and control at source does not reduce exposure sufficiently, enclosure of the noise source should be considered as the next step. In designing enclosures, several factors should be taken into consideration if the enclosure is to prove satisfactory from both an acoustical and a production point of view, for example:

- (a) enclosure dimensions, wall and isolation;
- (b) internal absorption and protection of absorptive material;
- (c) providing for product flow and worker access;
- (d) ventilation of enclosure.

Enclosures should be designed and manufactured in accordance with the requirements and needs indicated by the user, consistent with internationally recognized plant and equipment standards.

9.3.5. If enclosure of the noise source is impracticable, employers should consider an alternative sound transmission path treatment using a barrier to block or shield the worker at risk from the noise hazard from the direct sound path. The effectiveness of a barrier is a function of its location relative to the noise source or workers to be protected and of its overall dimensions. Barriers should be designed and manufactured in accordance with the requirements and needs indicated by the user, consistent with internationally recognized plant and equipment standards.

9.3.6. If reducing the noise at source or intercepting it does not sufficiently reduce worker exposure, then the final options for reducing exposure should be:

- (a) to treat the working space or area, most practical for those job activities where workers' movement is confined to a relatively small area and an acoustical booth or shelter may be installed;
- (b) to minimize by appropriate organizational measures the time workers spend in the noisy environment.

Ambient factors in the workplace

9.3.7. Where the combination of all other practicable measures fails to reduce worker exposure sufficiently, employers should provide hearing protection devices and supervise their correct use by exposed workers and other persons. These devices should:

- (a) be selected in accordance with the needed reduction of the noise level;
- (b) be comfortable and practical for the working environment concerned;
- (c) take into account the individual's auditory needs (ability to hear warning signals, speech, etc.);
- (d) be used, maintained and stored properly, in accordance with the technical specifications provided by the manufacturer.

9.4. Health surveillance

9.4.1. Appropriate health surveillance should be conducted for all workers whose noise exposures reach a certain level prescribed by national laws and regulations or by national or internationally recognized standards above which health surveillance should be carried out.

9.4.2. Workers' health surveillance may include:

- (a) a pre-employment or pre-assignment medical examination to:
 - (i) determine any contraindication to exposure to noise;
 - (ii) detect any sensitivity to noise;
 - (iii) establish a baseline record useful for later medical surveillance;
- (b) periodical medical examinations at intervals prescribed as a function of the magnitude of the exposure hazards to:
 - (i) detect the first symptoms of occupational disease;
 - (ii) detect the appearance of any unusual sensitivity to noise and signs of stress due to noisy working conditions;
- (c) medical examinations prior to resumption of work after a period of extended sickness or in case of conditions as may be specified in national legislation or internationally recognized standards;
- (d) medical examinations performed on cessation of employment to provide a general picture of the eventual effects of exposure to noise;
- (e) supplementary and special medical examinations when an abnormality is found and it requires further investigation.

9.4.3. The results of the medical examinations and of supplementary examinations and tests, such as audiometric testing, of each individual should be recorded in a confidential medical file. The worker should be informed of these results and their significance accordingly.

9.5. Training and information

9.5.1. Employers should ensure that workers who may be exposed to significant levels of noise are trained:

- (a) in the effective use of hearing protection devices;
- (b) to identify and report on new or unusual sources of noise that they become aware of;
- (c) in the role of audiometric examination.

9.5.2. Employers should ensure that workers in noisy environments are informed of:

- (a) the factors leading to noise-induced hearing loss and the consequences for the victim, including non-auditory effects and social consequences, especially for young workers;
- (b) the precautions necessary, especially those requiring worker intervention or use of hearing protection devices;
- (c) the effects that a noisy environment may have on their general safety;
- (d) the symptoms of adverse effects of exposure to high levels of noise.

10. Vibration

10.1. Scope

10.1.1. This chapter gives additional and specific information to help employers, workers and competent authorities apply the general principles in Chapters 2 and 3.

10.1.2. Exposure of workers to hazardous vibration mainly comprises:

- (a) whole-body vibration when the body is supported on a surface which is vibrating, which occurs in all forms of transport and when working near vibrating industrial machinery;
- (b) hand-transmitted vibration, which enters the body through the hands and is caused by various processes in which vibrating tools or workpieces are grasped or pushed by the hands or fingers.

10.1.3. Exposure limits should be established according to current international knowledge and data. International consensus standards describe useful methods for quantifying vibration severity for whole-body vibration in ISO 2631-1:1997 and for hand-transmitted vibration in ISO 5349:1986. In addition to these standards and this code, the information on the assessment of vibration exposure and protective and preventive measures provided for in the Working Environment (Air Pollution, Noise and Vibration) Convention (No. 148), and Recommendation (No. 156), 1977, and the ILO code of practice *Protection of workers against noise and vibration in the working environment* (Geneva, 1984) should apply. Further detailed information can be found in section 10 of the annex.

10.2. Assessment

10.2.1. If workers or others are frequently exposed to hand-transmitted or whole-body vibration, and obvious steps do not eliminate the exposure, employers should assess the hazard and risk to safety and health from the conditions, and the prevention and control measures to remove the hazards or risks or to reduce them to the lowest practicable level by all appropriate means.

10.2.2. For the prevention of adverse effects of vibration on workers, employers should:

- (a) consider the sources of vibration and the tasks which give rise to exposure;
- (b) seek the advice of the competent authority about exposure limits and other standards to be applied;
- (c) seek the advice of the supplier of vehicles and equipment about their vibration emission;

- (d) if this advice is incomplete or otherwise of doubtful value, arrange for measurements by a technically competent person, to be carried out in accordance with currently available national and international knowledge.

10.2.3. Vibration measurements should be used to:

- (a) quantify the level and duration of exposure of workers and compare it with exposure limits as established by the competent authority or other standards to be applied;
- (b) identify and characterize the sources of vibration and the exposed workers;
- (c) assess the need both for engineering vibration control and for other appropriate measures and for their effective implementation;
- (d) evaluate the effectiveness of particular vibration prevention and control measures.

10.2.4. The assessment should identify the ways in which vibrating tools are used, and determine in particular whether:

- (a) high-risk uses can be eliminated;
- (b) workers have been appropriately trained in the use of the tools;
- (c) their use can be improved by supports.

10.2.5. With a view to establishing appropriate prevention and control measures, the assessment should take into account:

- (a) exposure to cold at the workplace which can bring on symptoms of vibration white finger (Raynaud's phenomenon) in those exposed to vibration;
- (b) vibration of the head or eyes as well as vibration of the displays themselves which can affect the perception of displays;
- (c) body or limb vibration which can affect manipulation of controls.

10.3. Prevention and control

10.3.1. Manufacturers should:

- (a) provide vibration values for their tools;
- (b) redesign processes to avoid the need to use vibrating tools;
- (c) provide information to ensure that vibration is controlled by correct installation;
- (d) avoid resonance frequencies of the component parts of machinery and equipment;
- (e) use, as far as practicable, antivibration handles; consistent with national laws and regulations.

10.3.2. When purchasing equipment and industrial vehicles, employers should ascertain that the vibration exposure to the user is within prescribed national standards and otherwise does not pose a significant hazard or risk to the worker's safety and health.

Ambient factors in the workplace

10.3.3. Where old machinery is still in use, sources of vibration that present a risk to the safety and health should be identified and suitable modifications made by employing current knowledge of vibration-damping techniques, which may be provided by the original manufacturer. Basic requirements for reducing the exposure from vibrating tools should be:

- (a) the handle should be gripped as lightly as possible;
- (b) heavy tools should be supported to permit a lighter grip;
- (c) old tools which cannot be retrofitted with antivibration handles should be replaced with modern tools, where appropriate.

10.3.4. Seating in vehicles, including static plant with integral seating, should be designed to minimize transmission of vibration to the rider, and should permit an ergonomically good working position.

10.3.5. Many of the measures listed for noise control in paragraph 9.3.3 of this code will also be effective in reducing vibration generated by machinery and tools. Where workers are directly or indirectly exposed to vibration transmitted via the floor or other structures, the vibrating machines should be mounted on vibration isolators (antivibration mounts), according to the instructions of the manufacturer for their correct installation, or retrospectively designed and manufactured according to internationally recognized plant and equipment standards.

10.3.6. Machinery or vibrating tools should be maintained regularly because worn bearings, shaft misalignment, unbalanced rotating parts, loose bolts, damaged gear teeth, blunt cutting tools and neglected lubrication all combine to increase vibration levels.

10.3.7. Where the exposure might lead to injury if continued for a working lifetime, and reduction of the vibration is impracticable, the work should be rearranged to give rest periods or job rotation sufficient to reduce the overall exposure to a safe level.

10.3.8. As vibration effects in vehicles are dependent on vehicle speed and nature of terrain, employers should ensure that work scheduling permits travel at reasonable speed, and that work access roads under their responsibility are well maintained.

10.4. Health surveillance

10.4.1. A pre-employment medical examination should examine candidates for jobs affected by hand-arm vibration for Raynaud's phenomenon of non-occupational origin and for hand-arm vibration syndrome (HAVS) from previous employment. Where these symptoms are diagnosed, such employment should not be offered unless vibration has been satisfactorily controlled.

10.4.2. If a worker is exposed to hand-transmitted vibration, the occupational health professional responsible for health surveillance should:

- (a) examine the worker periodically, as prescribed by national laws and regulations, for HAVS and ask the worker about symptoms;
- (b) examine the worker for symptoms of possible neurological effects of vibration, such as numbness and elevated sensory thresholds for temperature, pain, and other factors.

10.4.3. If it appears that these symptoms exist and may be related to vibration exposure, the employers should be advised that control may be insufficient. The employer should review the assessment in accordance with section 3.2 of this code, and in particular control the causative vibration.

10.4.4. Because of possible association of back disorders with whole-body vibration, workers exposed should be counselled during health surveillance about the importance of posture in seated jobs, and about correct lifting technique.

10.5. Training and information

10.5.1. Employers should ensure that workers who are exposed to significant vibration are:

- (a) informed about the hazards and risks of prolonged use of vibrating tools;
- (b) informed on the measures within the workers' control which will minimize risk, particularly the proper adjustment of seating and working positions;
- (c) instructed in the correct handling and use of hand tools with a light but safe grip;
- (d) encouraged to report finger blanching, numbness or tingling, without facing unwarranted discrimination, for which there should be recourse in national law and practice.

Annex

Occupational exposure limits

1. Purpose

1.1. This annex is intended as a general introduction to exposure limits for the use of employers and other parties concerned, and indicates where more detailed information can be found. Although some illustrative values are quoted, it is not the purpose of this annex to list values, because these change continually as more technical information becomes available, and it is the responsibility of the competent authority to specify which exposure limits should be used and how.

2. General

2.1. An exposure limit (EL) is a level of exposure which is specified by a competent authority, or some other authoritative organization such as a professional body, as an indicator of the level to which workers can be exposed without serious injury. It is used as a general term and covers the various expressions employed in national lists, such as “maximum allowable concentration”, “threshold limit value”, “permissible level”, “limit value”, “average limit value”, “permissible limit”, “occupational exposure limit”, “industrial hygiene standards”, etc. The exact definition and intended application of ELs vary widely from one authority to another and the underlying definitions and assumptions and the requirements of the appropriate competent authority must be taken into account if they are used. For example, some authorities have promulgated ELs which are used as legally permitted “safe” levels of exposure and are intended to protect against “injury”, not against every health effect. Other authorities provide for limits which are intended as guidelines or recommendations in the control of potential workplace health hazards. An important example of the caution to be applied in using ELs is provided in the introduction to the annual publication *Threshold Limit Values (TLVs)* of the American Conference of Governmental Industrial Hygienists (ACGIH): TLVs “represent conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse health effects. Because of wide variation in individual susceptibility, however, a small percentage of workers may experience discomfort from some substances at concentrations at or below the threshold limit; a smaller percentage may be affected more seriously”. Consequently, any EL represents a risk which is felt to be acceptable based on a particular criterion, and where such limits are promulgated there is usually an additional requirement to keep exposure as low as practicable, rather than simply below the EL.

2.2. It is also important to take into account the averaging period for which the limit is intended. Some limits are ceiling values to be continuously applied; others apply to average exposures over a period of up to several years. A short-period limit requires stricter control than a longer-period limit at the same exposure value. For example, a limit applying to a month might allow the exposure to range above the value for days at a time, provided there was a compensating period of low exposure which

maintained the monthly average. If the same value were applied to 15-minute averages, the control would have to be good enough to keep every 15-minute average below the value.

2.3. ELs generally limit exposure of the individual, and measurements to be compared with the EL must therefore be taken close to the individual (“personal exposure”), unless the EL in question is clearly stated to be applicable to the general value in the workplace environment. A measurement result sometimes depends on the measurement method, and quality control of measurements is often important; employers should consult the occupational health service on these issues.

2.4. Some authorities issue lists of values to be used in biological monitoring or in biological effect monitoring. As with ELs, different lists are derived from different assumptions and are intended to be used in different ways. They include lists of values which are believed to be safe, and values which are not necessarily safe but which represent an acceptable standard of control.

3. General sources

3.1. It is the responsibility of the competent authority to specify what ELs should be used, and the responsibility of the employer to obtain this information from the competent authority for any particular hazard and to compare the EL values with exposure levels in workplaces, to verify whether exposure is being properly controlled. A large number of international, national and other authorities have published lists of legal or recommended ELs of various sorts, but usually only for chemicals. The most wide-ranging is the ACGIH TLV list, updated annually, which includes recommended EL values for airborne chemicals; biological monitoring limits; ionizing, non-ionizing and optical radiation; thermal stress; noise; and vibration. The International Programme on Chemical Safety (IPCS) produces IPCS International Chemical Safety Cards, which are peer-reviewed assessment documents. International organizations, such as the International Organization for Standardization (ISO) and the International Atomic Energy Agency (IAEA), produce technical standards on the measurement and control of several ambient factors with the objective of their being transferred to regional or national legislation.

3.2. For all the ambient factors dealt with in this code of practice, detailed guidance on ELs and other aspects of assessment and control is provided by the ILO *Encyclopaedia of Occupational Health and Safety* (Geneva, 1998). Some references concerning ELs for particular ambient factors are given in the following sections.

4. Hazardous substances

4.1. ELs for solids and non-volatile liquids are usually in mg/m^3 , that is, milligrams of the chemical in a cubic metre of air. ELs for gases and vapours are usually in ppm, that is, parts of the substance in a million parts of air, by volume, and also in mg/m^3 at a specified temperature and pressure. There is a smaller number of lists of limits for biological monitoring.

4.2. Many authorities have issued lists of ELs for airborne chemicals, on various assumptions (see paragraph 2.1 of this annex). The International Occupational Safety

Ambient factors in the workplace

and Health Information Centre (CIS) of the ILO maintains a database of the limits from different parts of the world. For the time being, peer-reviewed IPCS International Chemical Safety Cards are available for around 1,300 chemical substances.

4.3. There are European standards for:

- (a) the performance of measurement methods for airborne chemicals: EN 482: *Workplace atmospheres – General requirements for the performance of procedures for the measurement of chemical agents* (1994);
- (b) comparison of the results with ELs: EN 689: *Workplace atmospheres – Guidance for the assessment of exposure by inhalation to chemical agents for comparison with limit values and measurement strategy* (1996).

4.4. Recommended values are given in *Threshold limit values for chemical substances and physical agents and biological exposure indices, 1998* (United States, ACGIH, revised annually).

4.5. Prominent national standards are:

- (a) EH 40/97: *Occupational Exposure Limits, 1997* (United Kingdom, Health and Safety Executive (HSE), 1997) (revised annually);
- (b) Technische Regeln für Gefahrstoffe (TRGS 900) – *Grenzwerte in der Luft am Arbeitsplatz (Luft Grenzwerte)* (Germany, 1998) (revised annually).

5. Ionizing radiation

5.1. There is a well-established and authoritative international system for recommending limits for ionizing radiation, and most national authorities follow their recommendations. The main international bodies responsible are the International Commission on Radiological Protection (ICRP) and the International Atomic Energy Agency (IAEA).

5.2. The unit used to measure the activity of a given substance to emit radiation is the becquerel (Bq). The activity of an amount of a radionuclide is the average number of spontaneous nuclear transformations taking place per unit time. If the number of nuclear transformations is one per second, the activity of the substance is said to be one becquerel (Bq). A body exposed to an amount of radiation absorbs energy from it, and the unit of *absorbed dose* is the gray (Gy); a gray is equal to a joule per kilogram.

5.3. The effect of a given absorbed dose will depend on the type of radiation and the tissue involved. The degree of biological risk caused by different types of radiation can be calculated by multiplying the absorbed dose measured in gray (Gy) by a radiation weighting factor; the resulting quantity is the *equivalent dose*, measured in sievert (Sv). All doses given in Sv or mSv are comparable, regardless of the type of radiation involved. As some human organs are more sensitive to radiation than others, tissue weighting factors are used to demonstrate the equivalent risks of locally limited exposure and a whole body dose. To stress that the tissue weighting factors have been used, the term *effective dose* is applied. The unit of effective dose is also the sievert (Sv).

5.4. The dose limits recommended by the ICRP and the *Basic safety standards* (see paragraph 5.5 below) at present are that occupational exposure to ionizing radiation should not be higher than 50 mSv in any one year and the annual average dose over five

years should not exceed 20 mSv (100 mSv in any five-year period). As two tissues (the lens of the eye and the skin) will not necessarily be adequately protected by a limit on effective dose, mainly in the case of external exposure, separate dose limits are established for these tissues, i.e. an equivalent dose to the lens of the eye of 150 mSv in a year and to the extremities (hands and feet) or the skin of 500 mSv in a year.

5.5. Guidance on the application of the dose limits is given in the *International basic safety standards for protection against ionizing radiation and for the safety of radiation sources* (IAEA, Vienna, 1994).

6. Electric and magnetic fields

6.1. There are as yet no internationally accepted sets of limits for electric and magnetic fields corresponding to the ICRP recommendations on ionizing radiation, although some ELs have been recommended by the International Non-Ionizing Radiation Committee (INIRC) of the International Radiation Protection Association (IRPA) and by its successor, the International Commission on Non-Ionizing Radiation Protection (ICNIRP). Some limits proposed by these and other organizations are in terms of physical or physiological effect of the radiation and some in terms of the strengths of the fields. The relations between the units and quantities is complicated, and different quantities have been used in recommended ELs. Many of the recommendations depend on the frequency of the radiation. Units for the time-varying quantities usually refer to the root-meansquare (rms) values.

6.2. Guidelines and recommendations can be found in the practical guide on *Protection of workers from power frequency electric and magnetic fields*, ILO Occupational Safety and Health Series No. 69 (Geneva, 1994).

6.3. EN 50166:1995 *Human exposure to electromagnetic fields* (January 1995).

7. Optical radiation

7.1. Exposure limits for optical radiation are to be established for the different kinds of radiation. *Threshold Limit Values* (ACGIH, 1997) recommends that:

- (a) ELs for UV radiation be in terms of the radiant flux density (or irradiance) of the radiation at the eye, in mW/cm^2 , weighted according to the wavelength of the radiation;
- (b) ELs for visible light be in terms of the radiance of the source, i.e. the energy output per unit area of the source into each solid angle, weighted according to the wavelength of the radiation;
- (c) ELs for IR radiation be in terms of the radiant flux density at the eye, in mW/cm^2 , and unweighted for wavelength. However, for IR heat lamps there is also a limit in terms of the source's radiance.

7.2. The *Guidelines on protection against non-ionizing radiation* (IRPA, 1991) include ELs for lasers to protect the eye and skin. They are generally in terms of the energy density reaching the eye or skin (that is, in J/m^2 , equal to the radiant flux density in W/m^2 multiplied by the exposure time in seconds). The ELs vary with wavelength, and for visible and IR wavelengths are relaxed slightly as exposure time increases. Guidance on their use and further references on limits of exposure to laser radiation is

Ambient factors in the workplace

given in the practical guide on *The use of lasers in the workplace*, ILO Occupational Safety and Health Series No. 68 (Geneva, 1993). Control measures, however, are more easily specified in terms of the class of laser used than in terms of the ELs. The laser classification is specified in IEC 60/825-1: *Safety of laser products – Part 1: Equipment classification, requirements and users' guide* (International Electrotechnical Commission, 1998).

8. Heat and cold

8.1. A series of international standards, in particular of the International Organization for Standardization (ISO), is helpful in assessment and monitoring of the thermal environment. ISO 11399:1995 *Ergonomics of the thermal environment – Principles and application of relevant International Standards* is a useful guide to their application.

8.2. In *hot environments*, ISO 7243:1989 *Hot environments – Estimation of the heat stress on working man, based on the WBGT-index* gives a rapid method based on the wet bulb globe temperature (WBGT) index, which will be satisfactory under most conditions. It may provide insufficient protection for work in impervious clothing, in high radiant temperature, or a combination of high temperature and high air velocity. Under these more severe conditions, ISO 7933:1989 *Hot environments – Analytical determination and interpretation of thermal stress using calculation of required sweat rate* and ISO 9886:1992 *Ergonomics – Evaluation of thermal strain by physiological measurements* provide guidance for assessing individual response.

8.3. EN 563: *Safety of machinery – Temperatures of touchable surfaces – Ergonomics data to establish temperature limit values for hot surfaces* (1994).

8.4. In *moderate environments*, thermal comfort can be assessed using the predicted mean vote and predicted percentage dissatisfied techniques of ISO 7730:1994 *Moderate thermal environments – Determination of the PMV and PPD indices and specification of the conditions for thermal comfort*.

8.5. In *cold environments*, the technical report ISO/TR 11079:1993 *Evaluation of cold environments – Determination of requisite clothing insulation (IREQ)* provides guidance on required clothing insulation. This report does not have the status of a standard, but is approved for provisional application so that experience can be gained in its application. Two European standards, EN 342:1992 *Protective clothing against cold* and EN 511:1993 *Protective gloves against cold*, provide assessment methods for cold-weather clothing.

8.6. For both hot and cold environments, ACGIH (see paragraph 4.4) gives details of work/rest regimes.

9. Noise

9.1. Noise is conventionally measured in terms of the pressure of the sound wave. Because the ear responds roughly to the logarithm of the pressure, rather than its linear value, noise intensity is measured in decibels (dB), which are related to the logarithm of the ratio of the pressure of the sound to the pressure of a standardized least detectable sound. Also, the ear is more responsive to some frequencies than others, so

measurements and ELs are in terms of dB(A), which takes a frequency weighting into account. All authorities specify an EL in terms of dB(A) applicable to eight-hour exposures, with a formula to deal with other exposure periods, and in most cases a peak EL as well. Some authorities apply stricter standards to particular environments.

9.2. ISO 1999:1990 *Acoustics – Determination of occupational noise exposure and estimation of noise-induced hearing impairment* gives estimates of the hearing loss which will result from various exposure levels.

9.3. ISO 4871:1996 *Acoustics – Declaration and verification of the noise emission values of machinery and equipment*.

9.4. ISO 9612:1997 *Acoustics – Guidelines for the measurement and assessment of exposure to noise in a working environment*.

9.5. ISO 7196:1995 *Acoustics – Frequency-weighting characteristics for infrasound measurements*.

9.6. ISO 11690: 1996 *Acoustics – Recommended practice for the design of low-noise workplaces containing machinery. Part 1: Noise control strategies; Part 2: Noise control measures; Part 3: Sound propagation and noise prediction in workrooms*.

10. Vibration

10.1. ELs for vibration are usually in terms of the root-mean-square (rms) acceleration, frequency weighted to take human response into account. The standard is usually applied to eight-hour exposures, with a formula to account for shorter or longer periods.

10.2. For whole-body vibration, limits are applied to the longitudinal component (through the head and feet), to the two axes at right angles to this, and to a weighted combination of all three. ISO 2631-1:1997 *Mechanical vibration and shock – Evaluation of human exposure to whole-body vibration – Part 1: General requirements* provides general requirements.

10.3. For hand-transmitted vibration, limits are applied to frequency-weighted acceleration along three orthogonal axes centred at the point of contact of the hand and the tool. ISO 5349:1986 *Mechanical vibration – Guidelines for the measurement and the assessment of human exposure to hand-transmitted vibration* is currently under revision.

10.4. ISO 8041:1990 *Human response to vibration – Measuring instrumentation*.

Further reading

List of relevant Conventions and Recommendations

Conventions

<i>No.</i>	<i>Title</i>
115	Radiation Protection, 1960
135	Workers' Representatives, 1971
136	Benzene, 1971
139	Occupational Cancer, 1974
148	Working Environment (Air Pollution, Noise and Vibration), 1977
155	Occupational Safety and Health, 1981
161	Occupational Health Services, 1985
162	Asbestos, 1986
170	Chemicals, 1990
177	Home Work, 1996

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156	Working Environment (Air Pollution, Noise and Vibration), 1977
164	Occupational Safety and Health, 1981
171	Occupational Health Services, 1985
172	Asbestos, 1986
177	Chemicals, 1990
184	Home Work, 1996

ILO codes of practice

- Protection of workers' personal data, 1997
- Safety in the use of chemicals at work, 1993
- Radiation protection of workers (ionizing radiations), 1997
- Safety in the use of asbestos, 1984
- Protection of workers against noise and vibration in the working environment, 1984
- Occupational exposure to airborne substances harmful to health, 1980

Ambient factors in the workplace

ILO Occupational Safety and Health Series

ILO Technical and ethical guidelines for workers' health surveillance, No. 72, 1998

Safety in the use of radiofrequency dielectric heaters and sealers, No. 71, 1998

Visual display units: Radiation protection guidance, No. 70, 1994

Protection of workers from power frequency electric and magnetic fields, No. 69, 1994

The use of lasers in the workplace, No. 68, 1993

Dust control in the working environment (silicosis), No. 36, 1977

Other publications

ILO Encyclopaedia of Occupational Health and Safety, 1998

Hazard Prevention and Control in the Working Environment: Airborne Dust. Occupational and Environmental Health Series, World Health Organization (WHO, Geneva, 1999).

Other ILO publications

Encyclopaedia of occupational health and safety, fourth edition

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Completely revised and greatly expanded, the new edition of the *Encyclopaedia* provides comprehensive and authoritative coverage of occupational health and safety. It was developed through an extensive process of consultation with leading professionals and world-wide health and safety institutions. A new CD-ROM version provides the benefits of computer-assisted search and retrieval capabilities. The *Encyclopaedia* consists of four printed volumes:

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