



International  
Labour  
Office  
Geneva

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# Safety and health in the non-ferrous metals industries

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ILO code of practice

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**Safety and health  
in the non-ferrous metals  
industries**

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International Labour Office Geneva

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ILO

*Safety and health in the non-ferrous metals industries. ILO code of practice.*  
Geneva, International Labour Office, 2003

Code of practice, occupational safety, occupational health, metalworking industry.  
13.04.2

ISBN 92-2-111640-9

Also published in French: *La sécurité et la santé dans les industries de métaux non ferreux*. Recueil de directives pratiques du BIT (ISBN 92-2-211640-2, Geneva, 2003); and in Spanish: *La seguridad y la salud en las industrias de los metales no ferrosos*. Repertorio de recomendaciones prácticas de la OIT (ISBN 92-2-311640-6) Geneva, 2003.

*ILO Cataloguing in Publication Data*

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Photocomposed by the ILO, Geneva, Switzerland  
Printed in Italy

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## **Preface**

This ILO code of practice provides workers, employers and governments with global guidelines — based on international labour standards and established best practice — for addressing specific occupational hazards.

The code, which deals with the production of metal in bulk, focuses on foundries and on the production of primary non-ferrous metals, including from recycled material. It does not deal with mining, nor does it address the fabrication of commercial products made from non-ferrous metals.

This code was adopted unanimously by a Meeting of Experts on Safety and Health in the Non-ferrous Metals Industries, held in Geneva from 28 August to 4 September 2001. The good spirit of cooperation among all participants paved the way for developing a consensus on a comprehensive and practical code that, if it is widely applied, will be useful for all who work in the non-ferrous metals industries. The Governing Body of the ILO approved the publication of the code at its 282nd Session (November 2001).

The code begins by setting out the general principles of prevention and protection, including the duties of regulatory authorities, employers and workers. This first part covers a range of topics, including risk assessment, risk management, training, and workplace and health surveillance. The main part of the code identifies and examines a range of physical hazards that are commonly encountered during the production of non-ferrous metals. These include noise, vibration, heat stress, radiation, confined spaces, dust and chemicals. Separate chapters deal with furnaces, molten metal and recycling.

### **Safety and health in the non-ferrous metals industries**

The non-ferrous metals industry is diverse and is expanding. Increasingly sophisticated products are being produced using an array of chemicals and treatment processes in the smelting, refining and finishing stages. Recycling, including the separation of complex compound materials, is growing in importance for reasons related to the economy, and to protection of the environment and sustainable development.

This new code of practice provides practical guidelines for ensuring that the safety and health of all those involved in non-ferrous metals production, in large and small enterprises, are afforded the highest priority.

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## Preface

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## **Introduction**

In accordance with the decision taken by the Governing Body of the ILO at its 279th Session in November 2000, a Meeting of Experts on Safety and Health in the Non-ferrous Metals Industries was convened in Geneva from 28 August to 4 September 2001 to draw up and adopt a code of practice on safety and health in the production of non-ferrous metals. The Meeting was composed of eight experts appointed following consultations with governments, eight appointed following consultations with the Employers' group and eight appointed following consultations with the Workers' group of the Governing Body.

The code focuses on foundries and the production of primary non-ferrous metals, including from recycled material. It does not deal with mining, which is covered by Safety and Health in Mines Convention, 1995 (No. 176), nor does it deal with the fabrication of commercial products made from non-ferrous metals.

This code of practice is based on principles established in international instruments relevant to the protection of workers' safety and health. Chapters 1 to 3 deal with general provisions, principles and practices, and the duties of the competent authority, employers and workers and their representatives. Chapter 4 addresses general principles of prevention and protection. It covers a range of topics, including safety and health policy in the enterprise, risk assessment and risk management, investigating and reporting procedures, training, health and workplace surveillance, emergency preparedness and personal protection. Chapter 5 on specific measures of prevention and protection identifies and examines a range of physical hazards common in the

## **Safety and health in the non-ferrous metals industries**

production of non-ferrous metals. These include noise, vibration, radiation, heat stress, confined spaces, inhalable agents, chemicals, energy and transport. Where appropriate, this chapter draws on relevant parts of existing guidelines and codes of practice, including: *Guidelines on occupational safety and health management systems, ILO-OSH 2001* (Geneva, 2001); *Safety in the use of synthetic vitreous fibre insulation wools (glass wool, rock wool, slag wool)* (Geneva, 2001); *Ambient factors in the workplace* (Geneva, 2001); *Safety in the use of chemicals at work* (Geneva, 1993); *Occupational safety and health in the iron and steel industry* (Geneva, 1983); and *Technical and ethical guidelines for workers' health surveillance*, Occupational Safety and Health Series, No. 72 (Geneva, 1998). More detailed treatment of some of the broader aspects of safety and health in non-ferrous metals production can be found in these publications, particularly *Ambient factors in the workplace* and *Safety in the use of chemicals at work*. Chapters 6 to 10 cover specific topics, including furnaces, the handling of molten metal, process and waste gases, specific metals and recycling.

The practical recommendations of ILO codes of practice are intended for all those, both in the public and private sectors, who have responsibility for safety and health management in relation to specific occupational hazards (e.g. chemicals, heat, noise and vibration), sectors of activity (e.g. forestry, mining), or equipment. Codes of practice are not intended to replace national laws or regulations, or accepted standards. They are drawn up with the objectives of providing guidance to all those who may be engaged, through social dialogue, in the framing of provisions of this kind, or in elaborating programmes of prevention and protection at the

## **Introduction**

national or enterprise levels. They are addressed in particular to governmental and public authorities, employers and workers and their organizations, and management and safety and health committees in related enterprises.

Codes of practice are primarily designed as a basis for prevention and protective measures, and are considered as ILO technical standards in occupational safety and health. They contain general principles and specific guidance which concern, in particular, the surveillance of the working environment and of workers' health; education and training; record keeping; the role and duties of the competent authority, employers, workers, manufacturers and suppliers; and consultation and cooperation.

The provisions of this code of practice should be read in the context of the conditions in the country proposing to use the information contained in it, the scale of operation involved and technical possibilities. In this regard, the needs of developing countries are also taken into consideration.

## Definitions

In this code, the following terms have the meaning assigned to them in the definition below:

*Asbestos*: The fibrous form of mineral silicates belonging to rock-forming minerals of the serpentine group, i.e. chrysotile (white asbestos), and of the amphibole group, i.e. actinolite, amosite (brown asbestos), anthophyllite, crocidolite (blue asbestos), tremolite, or any mixture containing one or more of these.

*Asbestos dust*: Airborne particles of asbestos or settled particles of asbestos that are liable to become airborne in the working environment.

*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.

*Competent person*: A person with suitable training and sufficient knowledge, experience and skill for the safe performance of the specific work.

*Dangerous occurrence*: Readily identifiable event, as defined under national laws and regulations, with potential to cause an injury or disease to people at work or the general public, for example a “near-miss” or “near-hit”.

*Employer*: A legal person who produces non-ferrous metals and who has recognized responsibility, commitment and duties towards a worker in his or her employment by virtue of a mutually agreed relationship.

*Engineering controls*: Use of technical measures such as enclosure, ventilation and workplace design to minimize exposure.

*Exposure limit*: An exposure level specified or recommended by a competent authority to limit injury to health.

#### **Safety and health in the non-ferrous metals industries**

The terms adopted by the competent authority vary from country to country and include: “administrative control levels”; “maximum allowable concentrations”; “permissible exposure limits”; “occupational exposure limits”; and “threshold limit values”.

*Hazard:* The inherent potential to cause physical injury or damage to the health of people.

*Hazard assessment:* A systematic evaluation of hazards.

*HEPA filter:* High-efficiency particulate air filter that is capable of filtering out particles of 0.3 microns or less, such as bacteria.

*Incident:* An unsafe occurrence arising out of or in the course of work where no personal injury is caused.

*Insulation wools:* That group of products which includes glass wool, rock wool, refractory ceramic fibres (RCFs), refractory fibres other than RCFs and special-purpose glass fibres.

*Notification:* A procedure, specified in national laws and regulations, for establishing the way in which the employer or others directly concerned submit information concerning occupational accidents, dangerous occurrences or incidents, or occupational diseases, as appropriate and as prescribed by the competent authority.

*Occupational accident:* An unexpected occurrence, including acts of non-consensual violence, arising out of or in the course of work which results in fatal or non-fatal occupational injury.

*Occupational disease:* Disease known, under prescribed conditions, to arise out of exposure to substances or dangerous conditions in processes, trades or occupations.

*Occupational health services:* Services, such as regulated health-care providers, occupational hygienists, etc., en-



## Definitions

trusted with essentially preventive functions and responsible for advising the employer, the workers and their representatives in the enterprise on:

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

*Occupational health surveillance:* The ongoing and systematic collection, analysis, interpretation and dissemination of data for the purpose of prevention. Surveillance is essential to the planning, implementation and evaluation of occupational health programmes, and to the 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.

*Occupational safety and health management system:* Set of interrelated or interacting elements to establish occupational safety and health policy and objectives and to achieve those objectives.

*Recording:* A procedure, specified in national laws and regulations, for ensuring that the employer maintains information on:

- (i) occupational accidents and diseases;
- (ii) dangerous occurrences and incidents.

*Reporting:* A procedure, specified by the employer, in accordance with national laws and regulations and with the practice at the enterprise, for the submission by workers to

#### **Safety and health in the non-ferrous metals industries**

their immediate supervisor, the competent person, or any other specified person or body, of information on:

- (i) any occupational accident or injury to health which arises in the course of or in connection with work;
- (ii) suspected cases of occupational diseases;
- (iii) dangerous occurrences and incidents.

*Risk:* A combination of the likelihood of an occurrence of a hazardous event and the severity of injury or damage to the health of people caused by this event.

*Risk assessment:* The process for evaluating the risks to safety and health at work arising from hazards at work.

*Safety and health committee:* A committee set up to advise on safety and health matters. The composition of such a committee includes representatives of employers and workers.

*Screening criteria:* The values or requirements against which the significance of the identified hazard or effect can be measured. They should be based on sound scientific and technical information, and may be developed by the enterprise and industry or tripartite bodies, or provided by the regulators.

*Statutory provisions:* Regulations and all provisions given force of law by the competent authority.

*Supervisor:* A person responsible for the day-to-day planning, organization and control of a production function.

*Surveillance of the working environment:* A generic term including the identification and evaluation of environmental factors that may affect workers' health. It covers assessments of sanitary and occupational hygiene conditions, factors in the organization of work that may pose hazards or risks to workers' health, collective and personal protec-

## Definitions

tive equipment, exposure of workers to hazardous agents and control systems to eliminate or reduce them. From the standpoint of workers' health, the surveillance of the working environment may focus on, but not be limited to, ergonomics, accident and disease prevention, occupational hygiene in the workplace, work organization and psychosocial factors in the workplace.

*Worker:* Any person who performs work, either regularly or temporarily, for an employer.

*Workers' compensation:* Payment of compensation to workers or their families in the event of a temporary or permanent incapacity to work resulting from an injury or occupational disease sustained at or in connection with work.

*Workers' health surveillance:* A generic term covering procedures and investigations to assess workers' health in order to detect and identify any abnormality. The results of surveillance should be used 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:* In accordance with the Workers' Representatives Convention, 1971 (No. 135), persons who are recognized as such by national law or practice, whether they are:

- (i) trade union representatives, namely representatives designated or elected by trade unions or by members of such unions; or
- (ii) elected representatives, namely representatives who are freely elected by the workers of the enterprise, in

#### **Safety and health in the non-ferrous metals industries**

accordance with the provisions of national laws or regulations or of collective agreements, and whose functions do not include activities that are recognized as the exclusive prerogative of trade unions in the country concerned.

*Workers' safety and health representative:* A workers' representative elected or appointed in accordance with national laws, regulations and practice to represent workers' interests in occupational safety and health at the workplace.

- *Consultation of workers and their representatives:* Where this code refers to the consultation of workers and their representatives, the intention is that, where representatives exist, they should be consulted as the means to achieve appropriate workers' participation. In some instances, it may be appropriate to involve all workers and all representatives.

*Workplace:* Covers all places under the control of an employer where workers need to be or to go due to their work.

*Work-related injuries, ill health and diseases:* Negative effects on health arising from exposure to chemical, biological, physical, work-organizational and psychosocial factors at work.

## **1. General provisions**

### **1.1. Objectives**

1.1.1. The objectives of this code are:

- (i) to protect workers in the non-ferrous metals industries from occupational safety and health hazards or risks in the production of non-ferrous metals;
- (ii) to prevent or reduce the incidence and severity of illness and injury in the production of non-ferrous metals; and
- (iii) to promote the fullest consultation and cooperation between governments, employers and workers' organizations, in the improvement of occupational safety and health in the production of non-ferrous metals.

1.1.2. This code provides practical guidance on the role and obligations of the competent authorities and the responsibilities, duties and rights of employers, workers and all other parties involved, with regard to workplace hazards. In particular it covers:

- (i) the setting up of legal, administrative and effective frameworks for the prevention and reduction of hazards and risks;
- (ii) the aims of any mechanisms for identifying, eliminating, minimizing and controlling hazards;
- (iii) the assessment of risks and hazards to the safety and health of workers and the measures that need to be taken;
- (iv) the surveillance of the working environment and workers' health;
- (v) emergency procedures and first aid;

#### **Safety and health in the non-ferrous metals industries**

- (vi) the provision of information and training to workers;
- (vii) the establishment of a system to record, report and monitor occupational accidents and diseases, and dangerous occurrences.

1.1.3. 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). Recent guidance on ambient factors at the workplace – such as heat, noise and vibration – over and above that contained in this code, is provided by the ILO code of practice *Ambient factors in the workplace* (Geneva, 2001).

#### **1.2. Scope and application**

1.2.1. This code applies to:

- (i) all those institutions, whether legislative or advisory, whose activities influence the safety, health and welfare of people engaged in the production of non-ferrous metals, as appropriate to their function;
- (ii) all those individuals at the level of the enterprise or undertaking (i.e. employers, people in control of premises, workers and service contractors), as appropriate to their duties and responsibilities for safety and health;
- (iii) all activities in the production of non-ferrous metals, excluding mining and including the primary and secondary production of metals and metal alloys using hydrometallurgical or pyrometallurgical processes, and foundries.

1.2.2. The provisions of this code should be considered as a minimum. They are not intended to replace applicable

#### **General provisions**

laws, regulations or accepted standards laying down higher requirements. More stringent applicable requirements should have priority over the provisions of this code.

1.2.3. The code contains references to those institutions responsible for the delivery and award of vocational qualifications. Such institutions are urged to review existing curricula in the light of the code's recommendations for training and the allocation of worksite responsibilities.

## **2. General principles and practices**

### **2.1. Principles**

2.1.1. Satisfactory safety and health levels in the production of non-ferrous metals are achieved when a number of closely related principles have been applied at national, enterprise and worksite levels. These principles include compliance with laws and regulations, and a clearly defined policy to highlight the duty of employers to identify and evaluate, in consultation with workers' representatives, the nature and severity of the hazards and/or risks to workers associated with the production of non-ferrous metals, as well as the allocation of responsibility to those employed at the levels of management, supervision and execution.

2.1.2. Non-ferrous metals production enterprises vary considerably in terms of type of metal produced, size, technology, economic stability and culture. These differences should not, however, serve as a justification for diluting the application of those general principles essential to the promotion of working conditions that prevent or reduce the risk of injury or ill health.

### **2.2. Organizational measures**

2.2.1. The prevention or reduction of occupational risks due to the production of non-ferrous metals should be:

- (i) based on the general principles of occupational safety and health, taking due account of the relevant provisions of the Occupational Safety and Health Convention, 1981 (No. 155), and Recommendation, 1981 (No. 164), of the Working Environment (Air Pollution,



#### **General principles and practices**

Noise and Vibration) Convention, 1977 (No. 148), and Recommendation, 1977 (No. 156), and of the Labour Inspection Convention, 1947 (No. 81), and Recommendation, 1947 (No. 81); and

- (ii) conducted within the general framework of the organization of occupational safety and health at the enterprise level, taking due account of the relevant provisions of the Occupational Health Services Convention, 1985 (No. 161), and Recommendation, 1985 (No. 171).

2.2.2. The basic approach of the assessment of occupational hazards, evaluation of risks, and control with a view to continuing improvement should be followed as regards occupational hazards due to the production of non-ferrous metals, as it should for other occupational hazards present at the workplace (such as chemicals, dust, heat, noise, vibration, light and radioactive materials). This approach should include surveillance of the working environment and of workers' health.

2.2.3. The application of the provisions of this code should take into account the following recognized hierarchy of preventive and protective measures:

- (i) eliminate the risk by using products or technologies that permit risks to be eliminated or reduced to a minimum;
- (ii) control the risk at source, such as by isolation of the process and by engineering control measures;
- (iii) minimize the risk, e.g. by technical and administrative measures, and safe work practices;
- (iv) use appropriate personal protective equipment (PPE).

## **Safety and health in the non-ferrous metals industries**

### **2.3. Procedures**

2.3.1. Procedures should be developed for the specific needs of each operation,<sup>1</sup> and should include provisions on:

- (i) hazard identification and risk assessment;
- (ii) engineering control measures and technical measures;
- (iii) protective clothing and equipment;
- (iv) adequate information, such as chemical and material safety data sheets;
- (v) education and training, such as manuals on work procedures;
- (vi) allocation of responsibilities, including arrangements for consultation; and
- (vii) review of process and improvement plans.

2.3.2. Procedures, such as safe work practices, should be developed for all stages of the production of non-ferrous metals. They should be developed, and their implementation should be monitored, in consultation with workers and/or their representatives, so as to benefit from knowledge gained from experience.

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<sup>1</sup> Technical information and guidance documents can be found in the ILO-CIS database on occupational safety and health (CISDOC); web site: <http://www.ilo.org/public/English/protection/safework/cis/index.htm>

### **3. General duties**

#### **3.1. Cooperation**

3.1.1. This code recognizes that an effective safety and health system requires joint commitment between the competent authority, employers, workers and their representatives. The parties should cooperate in a constructive manner to ensure that the objectives of this code of practice are achieved.

3.1.2. To ensure the elimination or control of hazards or risks to safety and health from the production of non-ferrous metals, this cooperation should extend to the application of the measures provided by this code; those relevant measures of the codes of practice *Ambient factors in the workplace* (Geneva, 2001) and *Safety in the use of chemicals at work* (Geneva, 1993); and the relevant provisions of the Workers' Representatives Convention, 1971 (No. 135), the Working Environment (Air Pollution, Noise and Vibration) Convention, 1977 (No. 148), and Recommendation, 1977 (No. 156), the Occupational Safety and Health Convention, 1981 (No. 155), and Recommendation, 1981 (No. 164), the Occupational Health Services Convention, 1985 (No. 161), and Recommendation, 1985 (No. 171), the Chemicals Convention, 1990 (No. 170), and Recommendation, 1990 (No. 177), and the ILO *Technical and ethical guidelines for workers' health surveillance* (Geneva, 1998).

3.1.3. In accordance with national laws and regulations, measures for cooperation should be taken relating to the elimination or control of hazards or risks to safety and health from the production of non-ferrous metals. These measures should include the following:

#### **Safety and health in the non-ferrous metals industries**

- (i) employers, in discharging their responsibilities, should cooperate as closely as possible with workers and/or their representatives;
- (ii) workers should cooperate as closely as possible with their fellow workers and their employers in the discharge by the employers of their responsibilities, and should comply with all prescribed procedures and practices;
- (iii) suppliers should provide employers with all necessary information as is available and required for the evaluation of any unusual hazards or risks to safety and health that might result from a particular hazardous factor in the production of non-ferrous metals.

#### **3.2. Competent authority**

3.2.1. The competent authority should, in the light of national conditions and practice and the provisions of this code, in consultation with the most representative organizations of employers and workers concerned:

- (i) devise and maintain a national policy on occupational safety and health; and
- (ii) consider making new, or updating existing, statutory provisions for eliminating or controlling hazards in the production of non-ferrous metals.

3.2.2. Statutory provisions should include regulations, approved codes of practice, exposure limits and procedures for consultation and dissemination of information.

3.2.3. The competent authority should establish:

- (i) systems, including criteria, for classifying substances that may be hazardous to health, i.e. raw materials, intermediary products, final products and by-products

#### **General duties**

that are used and produced in the production of non-ferrous metals;

- (ii) systems and criteria for assessing the relevance of the information required to determine whether one of the substances listed above is hazardous;
- (iii) requirements for marking and labelling substances provided for use in the production of non-ferrous metals, taking into account the need to harmonize such systems internationally;
- (iv) criteria for the information contained in the substance safety data sheets received by employers; and
- (v) systems and criteria for identifying safety hazards and appropriate risk control measures relating to machinery, equipment, processes and operations used in the production of non-ferrous metals.

The competent authority should set out the necessary rules to determine these criteria and requirements, but is not necessarily expected to undertake technical tasks or laboratory tests itself.

3.2.4. The competent authority should secure the enforcement of national laws and regulations concerning the policy mentioned above 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.

3.2.5. If justified on safety and health grounds, the competent authority should:

- (i) prohibit or restrict the use of certain hazardous processes or substances in the production of non-ferrous metals; or

#### **Safety and health in the non-ferrous metals industries**

- (ii) require advance notification and authorization before such processes and substances are used; or
- (iii) 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.

3.2.6. The competent authority should ensure that guidance is provided to employers and workers to help them comply with their legal obligations under the policy. The competent authority should provide assistance to employers, workers and their representatives in accordance with national laws and regulations.

### **3.3. Employers**

3.3.1. Employers have a duty to protect and promote the safety and health of workers. Employers should comply with the measures to be taken regarding hazards or risks to safety and health from the production of non-ferrous metals, including appropriate standards, codes and guidelines as prescribed, approved or recognized by the competent authority.

3.3.2. Employers should provide and maintain workplaces, plant, equipment, tools and machinery, and should organize work so as to eliminate or, if this is not possible, control hazards and risks in the production of non-ferrous metals, and be consistent with national laws and regulations.

3.3.3. Employers should set out in writing their respective programmes and arrangements as part of their general policy in the field of occupational safety and health, and the various responsibilities exercised under these arrange-

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ments. This information should be clearly communicated to their workers by oral, written or other suitable means, commensurate with the ability of the workers.

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

- (i) make an assessment of the hazards and risks to the safety and health of workers arising from the production of non-ferrous metals, requesting and making effective use of the information provided by the supplier of equipment or materials and from other reasonably available sources; and
- (ii) take all necessary measures to reduce exposure to eliminate or, if this not possible, control risks to safety and health identified in the above risk assessment.

3.3.5. In taking preventive and protective measures, the employer should address the hazardous factor or risk in accordance with the hierarchy set out in paragraph 2.2.3. If the employers, workers or their representatives cannot agree, the issue should be referred to the competent authorities in accordance with paragraph 3.2.6.

3.3.6. In accordance with national laws and regulations, as a minimum, employers should make the necessary arrangements to provide for:

- (i) regular surveillance of the working environment, and health surveillance;
- (ii) adequate and competent supervision of work and work practices;
- (iii) the application and use of appropriate control measures and the periodic review of their effectiveness;

#### **Safety and health in the non-ferrous metals industries**

- (iv) education and training to managers, supervisors and workers, and to workers' safety and health representatives, on issues relating to hazards in the production of non-ferrous metals; and
- (v) where necessary, measures to deal with emergencies and accidents, including first-aid arrangements.

3.3.7. Occupational safety and health measures should not involve any expenditure for the workers.

3.3.8. Employers should have in place arrangements to:

- (i) deal with accidents, dangerous occurrences and incidents that may involve hazards or risks to safety and health from the production of non-ferrous metals; and
- (ii) eliminate or control any risk to the safety and health of workers, and thereby to the public and the environment.

3.3.9. When 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 the production of non-ferrous metals to all workers without discrimination.

3.3.10. In accordance with the Tripartite Declaration of Principles concerning Multinational Enterprises and Social Policy (1977), 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, on request, to the competent authorities and the workers' and employers' organizations, information on the standards related to injuries and risks to safety and health from the production of non-ferrous metals, relevant to their local operations, which they observe in other coun-



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tries. The findings of any safety and health studies should be disclosed.

3.3.11. Employers should initiate and maintain a process of consultation and cooperation with workers and their representatives concerning all aspects of safety in the production of non-ferrous metals specified in this code, in particular as regards the measures of prevention and protection listed in paragraphs 3.3.1 to 3.3.10. This process should be carried out within the framework of safety and health committees, as recommended by Convention No. 155, through another mechanism determined by the competent authority or by voluntary agreements.

3.3.12. Employers should verify:

- (i) compliance with safety regulations;
- (ii) maintenance of safe working techniques;
- (iii) the care taken of machines and equipment, particularly any devices provided in the interest of safety;
- (iv) training in the use of and the care taken of personal protective equipment (PPE); and
- (v) the competence of managers, supervisors and workers for their tasks.

3.3.13. Managers and supervisors should implement the enterprise's safety and health policy, including through the selection of safe equipment, work methods and work organization, and the maintenance of high levels of skill. They should endeavour to reduce risks and hazards to safety and health in the activities for which they are responsible to as low a level as possible.

3.3.14. Managers and supervisors should ensure that workers receive adequate information and training on safety and health regulations, policies, procedures and requirements

#### **Safety and health in the non-ferrous metals industries**

in accordance with Chapter 4 of this code, and satisfy themselves that this information is understood.

3.3.15. Managers and supervisors should assign tasks to their subordinates in a clear and precise way. They should satisfy themselves that workers understand and implement the safety and health requirements.

3.3.16. Managers and supervisors should ensure that work is planned, organized and carried out in such a way as to eliminate or, if this is not possible, reduce the risk of accidents and the exposure of workers to conditions that may lead to injury or damage their health (see below for guidance).

3.3.17. In consultation with workers and/or their representatives, managers and supervisors should assess the need for additional instruction, training and education of workers by monitoring compliance with safety requirements.

3.3.18. When managers or supervisors observe non-compliance with safety and health regulations or codes of practice by any person, they should take corrective action immediately. If such action is unsuccessful, the problem should be referred to a higher level of management immediately.

#### **3.4. Workers' duties and rights**

3.4.1. Workers should have the duty to cooperate with the employer to achieve compliance with the duties and responsibilities placed on the employer pursuant to this code.

3.4.2. When workers or their representatives observe non-compliance with safety and health regulations or codes of practice by any person, they should take corrective action immediately. If such action is unsuccessful, the prob-

#### **General duties**

lem should be referred to a higher level of management immediately.

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

- (i) comply with prescribed safety and health measures;
- (ii) take all steps to eliminate or control hazards or risks to themselves and to others arising during the production of non-ferrous metals, including the proper care and use of protective clothing, facilities and equipment placed at their disposal for this purpose;
- (iii) report forthwith to their immediate supervisor or safety and health representative any unusual conditions at the workplace or affecting installations and equipment which they believe could present a hazard or risk to their safety or health or that of other people arising from the production of non-ferrous metals, and which they cannot deal with effectively themselves;
- (iv) 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.

3.4.4. Workers should participate in instruction and training programmes provided by the employer or required by the competent authority, and should demonstrate such acquired knowledge and understanding of safety and health measures on the job. Workers and their representatives should review the instruction and training programmes for effectiveness. Where they determine that these programmes are ineffective, they should make recommendations to the employer to improve their effectiveness.

#### **Safety and health in the non-ferrous metals industries**

3.4.5. Workers should participate and cooperate in exposure monitoring and health surveillance programmes required by the competent authority and/or provided by the employer for the protection of their health.

3.4.6. Workers and their representatives should participate in the process of consultation and cooperate with employers concerning all aspects of safety in the production of non-ferrous metals specified in this code, and in particular as regards measures of protection and prevention listed in 3.3.1 to 3.3.10.

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

- (i) be consulted regarding any hazards or risks to safety and health from the production of non-ferrous metals;
- (ii) inquire into and receive information from the employer regarding any hazards or risks to safety and health arising from the production of non-ferrous metals, including information from suppliers. This information should be provided in forms and languages easily understood by the workers;
- (iii) take adequate precautions, in cooperation with their employer, to protect themselves and other workers against hazards or risks to safety and health from the production of non-ferrous metals; and
- (iv) request, and be involved in, the assessment of hazards and risks to safety and health from hazardous factors to be conducted by the employer and/or by the competent authority. They should also have the right to be involved in relevant control measures and investigations.

3.4.8. Workers and/or their representatives should be involved in the introduction and development of workers'

#### **General duties**

health surveillance, and should participate and cooperate with occupational health professionals, with their employers and with occupational health professionals in its implementation.

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

- (i) of the reasons for the examinations and investigations relating to the safety and health hazards involved in their work;
- (ii) individually of the results of medical examinations, including pre-assignment medical examinations, and of the respective health assessments. The results of medical examinations should be kept confidential in accordance with national legislation and should not be used to discriminate against workers.

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

- (i) to bring to the attention of their representatives, the employer or the competent authority hazards or risks to safety and health arising from the production of non-ferrous metals;
- (ii) to appeal to the competent authority if they consider that the measures taken and the means used by the employer are inadequate for the purpose of ensuring safety and health at work;
- (iii) to remove themselves from danger resulting from the production of non-ferrous metals when they have reasonable justification to believe that there is an imminent and serious risk to their safety and health and that of other people. Such workers should inform their supervisor and/or safety and health representative immediately.

#### **Safety and health in the non-ferrous metals industries**

- (iv) in the case of a safety or health condition that places them at increased risk of harm, 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;
- (v) to receive adequate compensation if the case referred to in (iv) above results in loss of employment;
- (vi) to be provided with adequate medical treatment and compensation for occupational injuries and diseases resulting from the production of non-ferrous metals; and
- (vii) to refrain from using or to shut down equipment or a process, or to refrain from using a 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.

3.4.11. Workers who remove themselves from danger in accordance with the provisions of paragraph 3.4.10(iii) should be protected against undue consequences in accordance with national conditions and practice.

3.4.12. Workers who justifiably take those actions specified in paragraph 3.4.10(i), (ii) and (vii) should be protected from unwarranted discrimination, for which there should be recourse in national laws and practice.

3.4.13. Workers and their elected safety and health representatives should receive appropriate education and training and, where necessary, retraining in the most effective methods available for minimizing risks to safety and health from the production of non-ferrous metals, in particular in those areas referred to in Chapters 5-10 of this code.

#### **General duties**

3.4.14. Women workers should have the right, in the case of pregnancy or when breastfeeding, to alternative work not hazardous to the health of the unborn or nursing child, where such work is available, in order to prevent exposure to hazards during the production of non-ferrous metals, and to return to their previous jobs at the appropriate time.

## **4. General principles of prevention and protection**

### **4.1. Enterprise safety and health policy and management system**

#### **4.1.1. General**

4.1.1.1. The promotion and advancement of occupational safety and health systems are a shared goal of the employers and workers. Compliance with occupational safety and health requirements is the duty of the employer pursuant to national laws and regulations. The employer should show strong visible leadership and commitment to occupational safety and health (OSH) activities in the enterprise and make appropriate arrangements for the establishment of an occupational safety and health management system (OSH-MS). The OSH-MS should contain the main elements of policy, organizing, planning and implementation, evaluation and action for improvement, as shown in figure 4.1 and as elaborated in the *ILO Guidelines on occupational safety and health management systems, ILO-OSH 2001* (Geneva, 2001). The following summary of the five main elements is based on the guidelines.

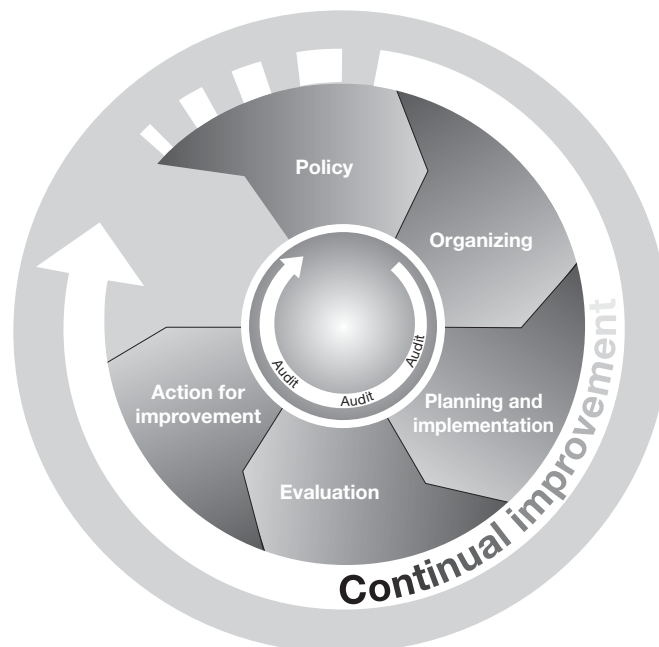
#### **4.1.2. Policy**

4.1.2.1. OSH policy should be specific and appropriate to the enterprise. The key objectives should be to: protect the safety and health of all members; comply with OSH requirements; continually improve performance of the OSH-MS; and have OSH-MS integrated in other systems. Workers' participation is necessary for: effective planning



## General principles of prevention and protection

Figure 4.1. Occupational safety and health management system (OSH-MS)



Source: ILO: *Guidelines on occupational safety and health management systems*, ILO-OHS 2001 (Geneva, 2001).

#### **Safety and health in the non-ferrous metals industries**

and implementation of the OSH-MS; consultation, information and training on all OSH aspects; and functioning of the safety and health committee and the recognition of workers' safety and health representatives.

##### **4.1.3. Organizing**

4.1.3.1. OSH is the employers' overall duty and responsibility. Employers and senior management should allocate responsibility, accountability and authority for the development, implementation and performance of the OSH-MS. All persons should be competent to carry out the safety and health aspects of their work, and competence requirements should be defined and necessary training programmes established. OSH management system documentation and records should be established and maintained according to the needs of the enterprise. They should be clearly written, understandable, kept properly and accessible. Arrangements for internal and external communications related to OSH should be established and maintained.

##### **4.1.4. Planning and implementation**

4.1.4.1. An initial review should be undertaken to establish a new OSH-MS or evaluate an existing OSH-MS to serve as the basis for OSH-MS planning and implementation, and as a baseline for measuring continual improvement. System planning, development and implementation should create an OSH-MS that complies with legal and other requirements, and improves OSH performance. OSH objectives should be focused towards the achievement of best OSH performance, be specific to the enterprise, and be realistic and achievable. Hazard prevention should encompass: prevention and control measures; management of

#### **General principles of prevention and protection**

change; emergency prevention, preparedness and response; procurement; and contracting.

##### **4.1.5. Evaluation**

4.1.5.1. Performance monitoring includes procedures to monitor, measure and record OSH performance on a regular basis using both active monitoring (inspection, surveillance) and reactive monitoring (following injuries, diseases, etc.). Deficient OSH performance and OSH-MS failures should be identified. The investigation of work-related injuries, ill health, diseases and incidents, and their impact on safety and health performance, should identify any failures of the OSH-MS and lead to the planning and implementation of corrective action. Audits are a critical aspect of ensuring the functioning and improvement of OSH-MS. Auditors should be competent and independent of the activity being audited. Both audits and auditor selection should be carried out in consultation with workers. Management reviews should enable the overall strategy to meet planned performance objectives and determine if there is a need for change to the OSH-MS, including policy and objectives. The findings should be shared with the OSH committee, workers and their representatives.

##### **4.1.6. Action for improvement**

4.1.6.1. OSH-MS performance monitoring, audits and management review should identify the root causes of any non-conformity with relevant OSH requirements and/or OSH-MS arrangements, and lead to appropriate arrangements including changes to the OSH-MS itself. Arrangements for the continual improvement of the OSH-MS should take into account the OSH objectives of the enterprise; the

#### **Safety and health in the non-ferrous metals industries**

results of hazard and risk identification, monitoring, health protection and promotion programmes and investigation; and changes in national laws and regulations, voluntary programmes and collective agreements.

4.1.6.2. All those participating in the OSH-MS and/or safety and health committee should have the authority bestowed on them that is necessary for them to properly fulfil their function.

#### **4.2. Risk assessment and risk management**

4.2.1. For effective prevention and protection against hazardous exposure in the non-ferrous metals industries, there should be collaboration between the planners and developers of processes, procedures and premises, and co-operation between workers and their representatives, managers and OSH professionals.

4.2.2. Such cooperation should focus on the identification and assessment of potential hazards and risks in the workplace, to ensure that measures are taken to eliminate or, if this is not possible, reduce the potential for occupational ill health and injury.

4.2.3. Guidance on issues to be included in the risk assessment should be available from manufacturers and suppliers of substances, machinery and other equipment. Further guidance would be available from the competent authority and external experts, e.g. occupational hygienists, competent engineers and specialists in occupational medicine.

4.2.4. Valuable information on daily working practices will be available from workers and their representatives; they will be able to assist employers in practices that have

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evolved on the premises and may have suggestions for improvements.

4.2.5. Consequently, even when workplace hazards have been effectively controlled, it is important to recognize the potential contribution to injury and illness from at-risk decisions and actions on the part of employers and workers.

4.2.6. The essential steps in a successful risk assessment are as follows:

- (i) observe processes and work activities in order to identify and quantify risks to safety and health, and the measures required to control them. It is at this stage that the guidance and information from those parties mentioned in paragraphs 4.2.3 and 4.2.4 should be taken into account to ensure that all relevant factors have been included;
- (ii) implement the necessary risk control measures, in an order of priority, starting with the most serious first. During, and immediately after, implementation the effectiveness of the measures being taken should be assessed to ensure that the identified control measures are adequate;
- (iii) provide information, instruction and training to all people who will be involved in maintaining the implemented risk control measures;
- (iv) periodically monitor, review and evaluate the continued effectiveness of the risk control measures and training programmes that have been implemented and, if appropriate, identify any required improvements. In particular, reviews should be carried out following any changes in process and personnel, and in the event of

#### **Safety and health in the non-ferrous metals industries**

dangerous occurrences. Any improvements identified in the review should be implemented; and

- (v) make a record of any changes in the risk assessment and the control measures.

4.2.7. People involved in a risk assessment should have:

- (i) sufficient training and experience in safety and health, and the processes being assessed, to effectively identify hazards and risks in the workplace and be able to assess the likelihood and severity of ill health and injury;
- (ii) the ability to carry out a risk assessment and make recommendations to employers, workers and their representatives on the implementation of the required risk controls;
- (iii) awareness of the limitations of their expertise, and when to seek guidance and information from competent sources when additional advice is required; and
- (iv) willingness to participate in continuous professional development initiatives in order to maintain and update their knowledge and skills.

4.2.8. Steps to minimize occupational risk factors centre on the reduction or elimination of harmful exposures (see paragraph 2.2.3). An expanded hierarchy of preventive and protective measures to be considered is:

- (i) eliminating hazardous substances from the processes and removing them from the site, wherever substances prohibited by local statutes or regulations are encountered;
- (ii) substituting harmful substances by harmless or less harmful agents;

#### **General principles of prevention and protection**

- (iii) enclosing the process to reduce exposure to hazardous substances, noise, etc.;
- (iv) automating work processes and systems to minimize the extent of direct exposure to the workforce;
- (v) limiting the quantities of hazardous agents kept on site;
- (vi) restricting access to areas of work or, whenever possible, minimizing the time workers spend in hazardous areas, bearing in mind that employers should not abuse job rotation as a means of spreading risk;
- (vii) minimizing cross-contamination and pollution of other workplaces or public environments from harmful substances generated by the work process;
- (viii) providing personal protective equipment (PPE) appropriate to the hazard.

#### **4.3. Investigating and reporting occupational accidents, occupational diseases and incidents**

##### **4.3.1. Investigating occupational accidents, occupational diseases and incidents**

4.3.1.1. In order to assess the risks, and take any corrective steps necessary, the employer, in cooperation with workers and their representatives, should investigate as soon as possible, based on the nature of the incident and in accordance with the requirements of the competent authority:

- (i) occupational accidents and incidents, whether or not they cause bodily injury;
- (ii) suspected and confirmed cases of occupational disease;
- (iii) situations where workers have removed themselves from danger; and

#### **Safety and health in the non-ferrous metals industries**

(iv) any other situation where there may be an unacceptable risk involving hazardous materials.

4.3.1.2. The investigation should be based on root cause analysis and should include not only a review of existing control measures but also underlying systemic factors.

4.3.1.3. Appropriate corrective action should be taken to prevent recurrence and to assess and monitor the effectiveness of actions taken.

4.3.1.4. Corrective actions should be implemented in all areas of the workplace where there is a risk of similar accidents occurring.

#### **4.3.2. Reporting occupational accidents, occupational diseases and incidents**

4.3.2.1. Occupational accidents, occupational diseases and incidents arising from the production of non-ferrous metals should be reported to the competent authority in accordance with national laws and practice.

4.3.2.2. The competent authority may specify and periodically review which diseases are prescribed as being of occupational origin and require reporting, in accordance with national laws and regulations.

#### **4.4. Information, training and competence**

##### **4.4.1. Information and training**

4.4.1.1. All those who work in the production of non-ferrous metals should be provided with sufficient information to protect their health from hazardous factors or substances which may be present, in a form and language that



#### **General principles of prevention and protection**

they understand, and sufficient training to understand the information and to take the necessary protective measures.

4.4.1.2. The form and content of the information and training should be devised and implemented in consultation with workers and/or their representatives, should meet the requirements of the competent authority as a minimum, and should include:

- (i) applicable laws, regulations and codes of practice;
- (ii) labels, and chemical and material safety data sheets;
- (iii) general and specific guidance on preventive measures, in particular on the procedures necessary to maintain exposures as low as practicable, safe work practices and personal protection;
- (iv) potential acute and chronic health effects that may result from exposure to hazardous materials;
- (v) emergency and first-aid measures; and
- (vi) information on the responsibilities of manufacturers, suppliers, employers and workers, as well as on the need for cooperation between them.

4.4.1.3. When necessary, employers should request advice and obtain expertise as regards risk assessments where there are particular difficulties because of multiple or combined exposures in the working environment, where health surveillance reveals abnormal findings concerning workers' health, or where alternative technologies or solutions to a difficult problem have been found.

4.4.1.4. New workers should receive specific training regarding the purposes and hazards of the chemicals, materials and processes with which they will be working, and periodically thereafter. Wherever practicable, this should include practical on-the-job training.

#### **Safety and health in the non-ferrous metals industries**

4.4.1.5. Following any changes in production procedures, the relevant competence of existing workers should be assessed and if necessary re-evaluated to determine the need for retraining and/or further training.

4.4.1.6. Employers' training programmes should be developed in consultation with workers and their representatives.

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

#### **4.4.2. Competence and review**

4.4.2.1. The extent of instruction and training should be appropriate to the duties, understanding and literacy of the workers, and sufficiently detailed to ensure that workers understand both the safety requirements and the reasons for these requirements. Trainees should not be assigned to work duties until they have assimilated thoroughly all relevant safe work practices.

4.4.2.2. Employers should ensure that people responsible for the provision of information, education and training, and exposure monitoring and assessment, have received appropriate and, where required by the competent authority, approved training or qualifications.

4.4.2.3. The extent of the instruction and training received and required should be reviewed and updated whenever work practices or working systems are reviewed.

4.4.2.4. The review should include the examination of:

- (i) whether workers understand the most effective use of the engineering control measures provided;

#### **General principles of prevention and protection**

- (ii) whether workers understand when protective equipment is required, and its limitations;
- (iii) whether workers are familiar with procedures in the event of an emergency;
- (iv) procedures for the exchange of information between shiftworkers; and
- (v) retention by workers of information provided by carrying out periodic supervision by competent persons.

#### **4.5. Surveillance of the working environment**

##### **4.5.1. Monitoring the workplace**

4.5.1.1. Trained and competent personnel should carry out sampling.

4.5.1.2. Appropriate instrumentation for sampling and analysis should be used.

4.5.1.3. Monitoring of the workplace should include:

- (i) identification and evaluation of hazardous factors that may affect workers' safety and health;
- (ii) assessment of conditions of occupational hygiene and factors in the organization of work that may give rise to hazards or risks to the safety and health of workers;
- (iii) assessment, where appropriate, of exposure of workers to hazardous agents;
- (iv) assessment of control systems designed to eliminate or reduce exposure; and
- (v) assessment of collective and personal protective equipment.

4.5.1.4. Where applicable, the monitoring of non-ferrous metals workplaces should be carried out in accordance with the requirements of the competent authority.

#### **Safety and health in the non-ferrous metals industries**

4.5.1.5. Such monitoring should be carried out in liaison with other technical services of the enterprise, and in cooperation with the workers concerned and their representatives and/or the safety and health committee.

4.5.1.6. Manufacturers and suppliers should make the results of workplace monitoring available to workers, their representatives and the competent authority.

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

4.5.1.8. The monitoring of the workplace should entail such visits by the personnel who provide occupational health services as may be necessary to examine the factors that may affect the workers' health, the environmental health conditions at the workplace and the working conditions.

#### **4.5.2. Measuring methods and strategy**

4.5.2.1. A sampling strategy should include location, timing, duration, frequency, and number of samples; each of these variables affects the interpretation of the results.

4.5.2.2. Sampling equipment should be compatible with the analytical methods available and should have been validated in accordance with national or international standards, where they exist.

4.5.2.3. Static monitoring should be used to determine the distribution of temperature and airborne material throughout the general atmosphere of the non-ferrous metal working area, and to identify problems and priorities. Measurements or samples should be taken: close to sources

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of emission; at various places in the working area to assess distribution; and in working areas which represent typical exposures.

4.5.2.4. In order to evaluate the risk of exposure to the individual worker, air samples should be collected in the worker's breathing zone by means of personal samplers. Sampling should be carried out while work is under way.

4.5.2.5. Where temperatures or concentrations of airborne material vary from one work operation or phase to another, measurements or personal sampling should be carried out in such a manner that the average, and in any case the maximum, level of exposure of each individual worker can be determined.

4.5.2.6. Personal sampling intended to evaluate time-weighted averages should be carried out over the broadest range of the work shift, supplemented where necessary by instantaneous or short-term sampling that will enable maximum levels of exposure to be established.

4.5.2.7. Exposure profiles of particular jobs or occupational categories should be constructed from the sampling data of different operations and from the workers' exposure in these jobs.

4.5.2.8. When required, non-ferrous metals workplace sampling should be conducted in a systematic way according to a monitoring programme developed after consultation with workers and their representatives.

4.5.2.9. The monitoring strategy should aim to ensure that:

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- (i) specific operations where exposures may occur are identified, and levels of exposure are quantified;
- (ii) exposures do not exceed exposure limits set or approved by the competent authority;
- (iii) preventive measures are effective in their implementation for all applications and in all jobs;
- (iv) any changes in work practices have not led to increased exposures; and
- (v) supplementary preventive measures are developed as necessary.

#### **4.5.3. Exposure limits**

4.5.3.1. Exposure limits, or other legal exposure criteria for the evaluation and control of the working environment, should be based on sound scientific and technical knowledge, as well as on an evaluation of occupational health hazards and risks based on the criteria listed in paragraph 2.2.3.

4.5.3.2. In accordance with national legislation and practice or guidance, and taking due account of the consultation provided for in paragraph 2.3.2, the exposure limits, or other legal exposure criteria for the evaluation and control of the working environment, should be established by:

- (i) statutory provisions; or
- (ii) an agreement between employers and workers at the national level that is approved by the competent authority; or
- (iii) other means approved by the competent authority, after consultation with competent scientific bodies and with the most representative organizations of the employers and workers concerned.

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4.5.3.3. Where it is reasonably practicable, or required by the competent authority, to achieve exposures below the exposure limits, or other legal exposure criteria for the evaluation and control of the working environment, then these lower exposures should be maintained. Exposure limits should be regarded as values above which remedial action should necessarily be taken, and as a tool to guide preventive and protective action with a view to continuing improvement.

4.5.3.4. The exposure limits, or other legal exposure criteria for the evaluation and control of the working environment, should be regularly reviewed in the light of technological progress and advances in scientific knowledge, as well as the results of workplace monitoring and experience.

4.5.3.5. Further information is contained in Appendix A.

#### **4.5.4. Interpretation and application of monitoring data**

4.5.4.1. The interpretation of the results of workplace monitoring in non-ferrous metals plants should include consideration of the working conditions at the time of the monitoring, and whether or not they were typical.

4.5.4.2. The results should be compared with the exposure limits determined by the competent authority, as well as with the results of previous monitoring carried out during the same or similar operations, at the same workplace or under similar conditions of exposure.

4.5.4.3. The results of workplace monitoring should be considered as levels requiring action, when:

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- (i) the exposure limits determined by the competent authority are exceeded; or
- (ii) the concentrations of materials are greater than those measured previously during the same or similar operations, at the same workplace or under similar conditions of exposure.

4.5.4.4. When workplace monitoring results have been interpreted as excessive, the necessary corrective action should be taken in a timely manner in consultation with the workers and their representatives. Follow-up monitoring should be carried out when the necessary corrective and preventive measures have been implemented or in the event of changes in the process.

4.5.4.5. When the results of workplace monitoring have been considered consistently satisfactory, the frequency of future monitoring should be determined in consultation with the workers and their representatives, and the competent authority if required.

#### **4.5.5. Record keeping**

4.5.5.1. The results of workplace and personal monitoring should be collected in a standardized way.

4.5.5.2. The records should be retained by employers for a period determined by the competent authority. For the purpose of epidemiological research, it is appropriate to maintain monitoring records for at least as long as medical records are maintained.

4.5.5.3. The records should include all relevant data such as details of the site, the source or sources of emissions, information on the functioning of the process, and the availability and wearing of personal protective clothing and equipment.



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4.5.5.4. Workers and their authorized representatives should have access to their own personal monitoring record, as well as to the workplace monitoring records.

#### **4.6. Workers' health surveillance**

##### **4.6.1. General provisions**

4.6.1.1. The central purpose of workers' health surveillance should be the primary prevention of occupational and work-related injuries and diseases in the production of non-ferrous metals.

4.6.1.2. Health surveillance programmes for workers in the production of non-ferrous metals should be consistent with:

- (i) the aims of occupational health as defined by the Joint ILO/WHO Committee on Occupational Health at its 12th Session, 1995;
- (ii) the requirements of the Occupational Health Services Convention, 1985 (No. 161), and Recommendation, 1985 (No. 171); and
- (iii) the *Technical and ethical guidelines for workers' health surveillance*, published by the ILO in 1998.

4.6.1.3. The establishment of workers' health surveillance programmes should be based on sound scientific and technical knowledge of non-ferrous metals processes and be in accordance with the requirements of the competent authority. A linkage should be established between the surveillance of workers' health and the surveillance of occupational hazards present at the workplace.

4.6.1.4. The surveillance of workers' health should be appropriate to the occupational risks at the workplace. The

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assessment of the level and type of surveillance appropriate to potential exposure of workers to materials in the production of non-ferrous metals should be based on a thorough investigation of all work-related factors that may affect workers' health.

4.6.1.5. Workers' health surveillance programmes should be designed and implemented in consultation with workers and their representatives.

#### **4.6.2. Monitoring and review**

4.6.2.1. Biological monitoring and/or health surveillance should be used, as appropriate, as an additional measure for monitoring ongoing exposure and to confirm the effectiveness of control measures.

4.6.2.2. Competent persons should also determine and specify the time intervals between any risk assessments.

4.6.2.3. The frequency of review should depend, in part, on the nature and extent of risks identified, and the availability and adequacy of control measures in place.

#### **4.6.3. Medical examinations**

4.6.3.1. As medical examinations are the most commonly used means of health assessment of individual workers, they should serve the following purposes:

- (i) the assessment of workers' health in relation to hazards or risks caused by exposure to hazardous factors, giving special attention to those workers with specific needs for protection in relation to their health condition;
- (ii) the detection of clinical and pre-clinical abnormalities at a point where intervention is beneficial to individual health;

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- (iii) the prevention of further deterioration in workers' health;
- (iv) the evaluation of the effectiveness of control measures at the workplace;
- (v) the reinforcement of safe methods of work and health maintenance; and
- (vi) the assessment of fitness for a particular type of work.

##### **4.6.3.2. Pre-assignment medical examinations should:**

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

4.6.3.3. During employment, periodic medical examinations should take place at intervals prescribed by national laws and regulations, and should be appropriate to the occupational risks of the enterprise.

4.6.3.4. Workers should have the right to request an assessment of health (i.e. a medical examination or other tests, as appropriate) if a disorder occurs which they believe to be due to or related to work in the production of non-ferrous metals.

4.6.3.5. Where the results of a medical examination indicate unacceptable exposure or effect, it should be incumbent on the employer to transfer the worker to a safer work location with no loss of pay. There should be a concomitant investigation of the circumstances of exposure or cause of the effect so that appropriate preventive action is taken where the individual returns to the same work.

4.6.3.6. Where people have been exposed to hazardous factors and, as a consequence, there is a significant risk to their health in the long term, suitable arrangements should

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be made for post-employment medical surveillance for the purpose of ensuring the early diagnosis and treatment of related diseases.

4.6.3.7. The competent authority should ensure that laws and regulations governing workers' health surveillance are properly applied.

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

- (i) clearly explained by professional health personnel to the workers concerned or to the person of their choice; and
- (ii) be kept confidential, only available to relevant medical staff, unless the worker has explicitly consented in writing to the release of all or part of such information, except where designated by the competent authority.

4.6.3.9. Workers should have the right of access to their own personal health and medical files, including at the time of retirement and thereafter.

4.6.3.10. Records of health surveillance should be retained in a confidential manner for 20 years from the last entry, or 40 years, whichever is longer, or in accordance with the requirements of the competent authority.

4.6.3.11. In the event of closure of the enterprise, any health surveillance records should be retained in a confidential manner by the competent authority.

#### **4.6.4. Occupational health services**

4.6.4.1. The employer should establish, or arrange for access to, an occupational health service for every non-ferrous metals plant.

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4.6.4.2. The employer should be responsible for emergency medical care.

4.6.4.3. The organization, functions, staffing and equipment of occupational health services should conform to the requirements laid down in the Occupational Health Services Recommendation, 1959 (No. 112).

#### **4.7. Emergency procedures and first aid**

##### **4.7.1. Emergency procedures**

4.7.1.1. Arrangements should be made to deal at all times, and in accordance with the requirements of the competent authority, or as advised by risk assessment, with emergencies and accidents that might arise from the use of hazardous materials in the production of non-ferrous metals.

4.7.1.2. These arrangements, and the procedures to be followed, should be kept up to date.

4.7.1.3. Workers should be trained in the relevant procedures, including raising the alarm, calling for appropriate emergency assistance, using PPE, evacuation, and action to minimize the incident. Procedures should be tested by regular drills.

##### **4.7.2. First aid**

4.7.2.1. Adequate first-aid arrangements should be provided in accordance with any requirements laid down by the competent authority, and having regard to the various types and sizes of non-ferrous metals production operations.

4.7.2.2. As far as is practicable, appropriate means and trained personnel to provide first aid should be readily

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available at all times during the use of hazardous materials in the production of non-ferrous metals.

4.7.2.3. As far as reasonably practicable, selected supervisory employees should undergo a training programme to enable them to qualify for a recognized first-aid certificate.

4.7.2.4. Where hazardous materials are used, first-aid personnel should be trained as regards:

- (i) the hazards associated with the materials and how to protect themselves from them;
- (ii) how to take effective action immediately; and
- (iii) any relevant procedures associated with sending a casualty to hospital.

4.7.2.5. The first-aid equipment and facilities should be appropriate for dealing with the hazards encountered in the production of non-ferrous metals. Suitable facilities should be available for workers to use themselves. These should be strategically placed to allow for their immediate use in the event of an emergency.

4.7.2.6. All workers should receive training in infection control procedures in the case of workplace accidents, and first aid.

4.7.2.7. There should be ready access at all times to first-aid equipment and to the facilities provided.

4.7.2.8. Properly equipped first-aid rooms should be provided in accordance with national laws or regulations.

#### **4.7.3. Fire-fighting**

4.7.3.1. Suitable fire-fighting equipment should be provided for the quantity and characteristics of the materials used in the production of non-ferrous metals. Adequate

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equipment should be available to cover the on-site transport and storage of non-ferrous metals and raw materials.

4.7.3.2. Fire-fighting equipment should be readily available and located in accordance with the requirements of the competent authority.

4.7.3.3. Fire-fighting and fire-protection equipment should be maintained in full working order, which should be ensured by regular inspection.

4.7.3.4. Suitable training, instruction and information should be given to workers about the hazards of fires involving chemicals, fuels or molten metal and the appropriate precautions to be taken. Where reliance is placed on trained firefighters, such arrangements should be emphasized and the action expected of workers clearly explained.

#### **4.8. Engineering controls**

4.8.1. The application of the provisions of this code should take into account the following recognized hierarchy of preventive and protective measures:

- (i) eliminate the risks by using products or technologies that permit risks to be eliminated or reduced to a minimum;
- (ii) control the risks at source, such as by isolation of the process and by engineering control measures;
- (iii) minimize the risks, e.g. by technical and administrative measures, and safe work practices;
- (iv) use appropriate PPE.

4.8.2. Engineering methods to control hazardous conditions in the non-ferrous metals industries include mechanical local exhaust ventilation, process or personnel enclosure and control of process conditions.

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4.8.3. A ventilation system separate from other exhaust ventilation systems should be used.

4.8.4. Exhaust should be transferred directly to the outside and dust collectors should be located outside, or wherever permitted by regulation.

4.8.5. Sufficient replacement air should be supplied to make up for air removed by exhaust systems.

4.8.6. Supervisors and colleagues should be aware of the danger of heat stress, particularly among foundry workers wearing full PPE. Regular breaks away from the furnace area should be taken as required and fluid replaced (see section 5.2.3).

4.8.7. The choice of PPE is important, as devices suitable for temperate countries may be uncomfortable and impractical for use in hot and humid climates. See section 4.9 for details on personal protection.

4.8.8. Ventilation systems should be designed/evaluated to ensure that they do not inadvertently recirculate contaminated air.

#### **4.9. Personal protection**

##### **4.9.1. Personal protective equipment**

4.9.1.1. Where adequate protection against exposure to hazardous factors in the production of non-ferrous metals cannot be ensured by other means, such as eliminating the risk, controlling the risk at source, or minimizing the risk (see paragraph 2.2.3), suitable 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, with-



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out cost to the workers, as may be prescribed by national laws and regulations.

4.9.1.2. PPE should not be regarded as a substitute for engineering and technical measures. It should be regarded as a last resort, as a temporary measure, or in an emergency.

4.9.1.3. The selection of protective clothing should take into account:

- (i) the adequacy of the design and the fit of the clothing, allowing freedom of movement to perform tasks, and whether it is suitable for the intended use;
- (ii) the environment in which it will be worn, including the ability of the material from which it is made to resist penetration by chemicals, minimize heat stress, release dust, resist catching fire and not discharge static electricity; and
- (iii) the special requirements of workers exposed to molten metal and associated hazards, such as the need for reflective clothing or insulated clothing with reflective surfaces during exposure to high radiant heat and hot air (see also section 5.2.3).

4.9.1.4. Sufficient PPE should be selected where appropriate on a personal basis. It should be used, maintained, stored and replaced in accordance with standards or guidance for each hazard set or recognized by the competent authority.

4.9.1.5. Different items of PPE should be compatible with each other when they are worn together.

4.9.1.6. PPE should not restrict the user's mobility or field of vision.

4.9.1.7. Employers should ensure that workers required to wear PPE are fully informed of the requirements

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and of the reasons for them, and are given adequate training in the selection, wearing, maintenance and storage of this equipment.

4.9.1.8. When workers have been informed accordingly, they should use the equipment provided throughout the time they are exposed to the risk that requires the use of PPE for protection.

4.9.1.9. Items of special equipment for use in proximity to molten metal should protect the wearer from heat and should withstand splashes of molten metal. It should be possible to remove these items easily if molten matter gets between the body and the protective clothing.

4.9.1.10. When tasks are performed using hazardous chemicals, PPE should be provided in accordance with the ILO code of practice *Safety in the use of chemicals at work* (Geneva, 1993).

4.9.1.11. All necessary protective equipment provided should be maintained in good condition and replaced, at no cost to the worker, when no longer suitable for the purpose.

4.9.1.12. The protective equipment should not be used for longer than the time indicated by the producer.

4.9.1.13. Workers should make proper use of the equipment provided, and maintain it in good condition, as far as this is within their control.

4.9.1.14. Before reissuing the clothing or equipment, employers should provide for the laundering, cleaning, disinfecting and examination of protective clothing or equipment which has been used and may be contaminated by materials that are hazardous to health.

4.9.1.15. Protective equipment that may be contaminated by materials hazardous to health should not be laun-

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dered, cleaned or kept at workers' homes. Employers should ensure that workers do not take contaminated clothing home and should provide for the cleaning of such clothing at no cost to the worker.

#### **4.10. Personal hygiene**

4.10.1. Adequate washing facilities, including hot and cold or warm running water, together with soap or other cleaning materials and towels or other drying equipment, should be provided.

4.10.2. The washing facilities should be conveniently accessible but situated so that they are not themselves exposed to contamination from the workplace.

4.10.3. Suitable toilets should be provided by the employer.

4.10.4. Toilets, washing facilities and areas set aside for eating should be kept clean and in a hygienic condition by the employer.

4.10.5. The type of washing facilities should be related to the nature and degree of exposure.

4.10.6. Facilities for storing personal clothing should be provided when protective clothing is used or when there is a risk of the contamination of personal clothing by hazardous materials.

4.10.7. Changing facilities should be situated and designed so as to prevent the spread of contamination from protective clothing to personal clothing and from one facility to another.

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4.10.8. To reduce the risk of ingesting materials hazardous to health, workers should not eat, chew, drink or smoke in a work area contaminated by such materials. If it is necessary to prohibit eating or drinking at the workplace, suitable facilities should be set aside for these activities to be carried out in an uncontaminated area, which should be conveniently accessible to the work area.

4.10.9. Floors should be slip resistant and well drained.

4.10.10. Spillages, leaks and splashes should be promptly cleaned up.

## **5. Prevention and protection specific to non-ferrous metals production processes**

### **5.1. Hazards and health effects**

5.1.1. The choice and implementation of specific measures for preventing workplace injury and ill health in the workforce of the non-ferrous metals industries depend on the recognition of the principal hazards, and the anticipated injury and illness. Below are the most common causes of injury and illness in the non-ferrous metals industries:

- (i) slips, trips and falls on the same level;
- (ii) unguarded machinery;
- (iii) falls from height;
- (iv) falling objects;
- (v) exposure to asbestos;
- (vi) exposure to mineral wools and fibres;
- (vii) contact with hot metal;
- (viii) fire and explosion;
- (ix) extreme temperatures;
- (x) radiation (non-ionizing, ionizing);
- (xi) noise and vibration;
- (xii) working in confined spaces;
- (xiii) inhalable agents (gases, vapours, dusts and fumes);
- (xiv) moving machinery and on-site transport;
- (xv) skin contact with chemicals (irritants (acids, alkalis), solvents and sensitizers);
- (xvi) exposure to controlled and uncontrolled energy sources;

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- (xvii) electrical burns and electrocution;
- (xviii) manual handling and repetitive work;
- (xix) exposure to pathogens (e.g. legionella).

### **5.2. Physical hazards**

#### **5.2.1. Noise<sup>1</sup>**

##### **5.2.1.1. Hazard description**

5.2.1.1.1. Exposure to noise levels exceeding those set by the competent authorities may result in occupational deafness. Exposure to high noise levels may also interfere with speech communication and may result in nervous fatigue.

##### **5.2.1.2. Assessment of risk**

5.2.1.2.1. 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:

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

5.2.1.2.2. In order to prevent adverse effects of noise on workers, employers should:

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<sup>1</sup> This section is drawn from Chapter 9 of the ILO code of practice *Ambient factors in the workplace* (Geneva, 2001).

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- (i) identify the sources of noise and the tasks that give rise to exposure;
- (ii) seek the advice of the competent authority and/or the occupational health service about exposure limits and other standards to be applied;
- (iii) seek the advice of the supplier of processes and equipment about expected noise emission; and
- (iv) if this advice is incomplete or otherwise of doubtful value, arrange for measurements by people who are able to undertake these in accordance with current national and/or internationally recognized standards.

##### **5.2.1.2.3. Noise measurements should be used to:**

- (i) 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 Appendix A, section 8);
- (ii) identify and characterize the sources of noise and the exposed workers;
- (iii) create a noise map for the determination of risk areas;
- (iv) assess the need both for engineering noise prevention and control, and for other appropriate measures and their effective implementation; and
- (v) evaluate the effectiveness of existing noise prevention and control measures.

##### **5.2.1.3. Control strategies**

###### **5.2.1.3.1 General**

5.2.1.3.1.1. Based on the assessment of the exposure to noise in the working environment, the employer should

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establish a noise-prevention programme with the aim of eliminating the hazard or risk, or reducing it to the lowest practicable level by all appropriate means.

##### ***5.2.1.3.2. Training and information***

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

- (i) the effective use of hearing-protection devices;
- (ii) identifying and reporting on new or unusual sources of noise that they become aware of; and
- (iii) the role of audiometric examination.

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

- (i) 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;
- (ii) the precautions necessary, especially those requiring workers' intervention or the use of hearing-protection devices;
- (iii) the effects that a noisy environment may have on their general safety; and
- (iv) the symptoms of adverse effects of exposure to high levels of noise.

##### ***5.2.1.3.3. Isolation, substitution, engineering controls***

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



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- (i) specify low noise output of the processes and equipment as a condition of purchase alongside production-related specifications; and
- (ii) arrange the workplace layout to minimize noise exposure to the workers.

5.2.1.3.3.2. 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. If elimination of the noisy process as a whole is not practicable, employers should consider replacing its noisy parts with quieter alternatives.

5.2.1.3.3.3. 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 be to attempt to control it at source. Such measures may also be effective in reducing vibration.

5.2.1.3.3.4. If prevention and control at source do 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, including workers' access and ventilation. 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.

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5.2.1.3.3.5. 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 resulting from the direct path of the sound. 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.

5.2.1.3.3.6. If reducing the noise at source or intercepting it does not sufficiently reduce workers' exposure, then the final options for reducing exposure should be to:

- (i) install an acoustical booth or shelter for those job activities where workers' movement is confined to a relatively small area;
- (ii) minimize by appropriate organizational measures the time workers spend in the noisy environment.

#### **5.2.1.3.4. *Personal protective equipment***

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

- (i) be selected in accordance with the needed reduction of the noise level;
- (ii) be comfortable and practical for the working environment concerned;

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- (iii) take into account the individual's auditory needs (ability to hear warning signals, speech, etc.); and
- (iv) be used, maintained and stored properly, in accordance with the technical specifications provided by the manufacturer.

##### **5.2.1.4. Health surveillance – Secondary prevention**

5.2.1.4.1. 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.

5.2.1.4.2. Workers' health surveillance may include:

- (i) a pre-employment or pre-assignment medical examination;
- (ii) periodical medical examinations at intervals prescribed as a function of the magnitude of the exposure hazards;
- (iii) medical examinations after periods of extended sickness or for conditions as may be specified in national legislation or internationally recognized standards;
- (iv) medical examinations performed on cessation of employment to provide a general picture of the eventual effects of exposure to noise; and
- (v) supplementary and special medical examinations when an abnormality is found that requires further investigation.

5.2.1.4.3. 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.

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### **5.2.2. Vibration <sup>2</sup>**

#### **5.2.2.1. Hazard description**

5.2.2.1.1. Exposure of workers to hazardous vibration is mainly known as:

- (i) whole-body vibration, when the body is supported on a surface that is vibrating, which occurs in all forms of transport and when working near vibrating industrial machinery; or
- (ii) 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.

5.2.2.1.2. Exposure limits should be established according to current international knowledge and data. Further detailed information can be found in Appendix A, section 9.

#### **5.2.2.2. Assessment of risk**

5.2.2.2.1. 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 resulting from the conditions, and the prevention and control measures to remove them or to reduce them to the lowest practicable level by all appropriate means.

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

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<sup>2</sup> This section is drawn from Chapter 10 of the ILO code of practice *Ambient factors in the workplace* (Geneva, 2001).

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- (i) consider the sources of vibration and the tasks that give rise to exposure;
- (ii) seek the advice of the competent authority about exposure limits and other standards to be applied;
- (iii) seek the advice of the supplier of vehicles and equipment about their vibration emissions; or
- (iv) if this advice is incomplete or otherwise of doubtful value, arrange for measurements by a technically capable person, to be carried out in accordance with currently available national and international knowledge.

5.2.2.2.3. Vibration measurements should be used to:

- (i) 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;
- (ii) identify and characterize the sources of vibration and the exposed workers;
- (iii) assess the need both for engineering vibration control and for other appropriate measures, and for their effective implementation; and
- (iv) evaluate the effectiveness of particular vibration-prevention and vibration-control measures.

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

- (i) high-risk uses can be eliminated;
- (ii) workers have had the right training in the use of the tools; and
- (iii) their use can be improved by supports.

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

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

#### **5.2.2.3. Control strategies**

##### ***5.2.2.3.1. Training and information***

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

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

##### ***5.2.2.3.2. Isolation, substitution, engineering controls***

5.2.2.3.2.1. Manufacturers should, in accordance with national laws and regulations:

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- (i) provide vibration values for their tools;
- (ii) redesign processes to avoid the need to use vibrating tools;
- (iii) provide information to ensure that vibration is controlled by correct installation;
- (iv) avoid resonance frequencies of the component parts of machinery and equipment; and
- (v) use, as far as practicable, anti-vibration handles.

5.2.2.3.2.2. 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.

5.2.2.3.2.3. Where old machinery is still in use, sources of vibration that present a risk to safety and health should be identified and suitable modifications made by employing current knowledge of vibration-damping techniques.

5.2.2.3.2.4. 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.

5.2.2.3.2.5. Many of the measures for noise control listed in paragraph 5.2.1.3 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 (anti-vibration mounts), installed according to the manufacturer's instructions or designed and manufactured according to internationally recognized plant and equipment standards.

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5.2.2.3.2.6. Machinery or vibrating tools should be maintained regularly because worn components combine to increase vibration levels.

5.2.2.3.2.7. 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.

#### **5.2.2.4. Health surveillance – Secondary prevention**

5.2.2.4.1. 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.

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

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

5.2.2.4.3. If it appears that these symptoms exist and may be related to vibration exposure, the employer should be advised that control may be insufficient. The employer



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should review the assessment, and in particular control the causative vibration.

5.2.2.4.4. 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 techniques.

#### **5.2.3. Heat stress<sup>3</sup>**

##### **5.2.3.1. Hazard description**

5.2.3.1.1. Heat stress can occur:

- (i) where temperatures and/or humidity are unusually high;
- (ii) where workers are exposed to high radiant heat;
- (iii) where high temperatures and/or humidity occur in combination with protective clothing or a high work rate.

##### **5.2.3.2. Assessment of risk**

5.2.3.2.1. If workers are exposed for all or part of their tasks to any conditions listed in paragraph 5.2.3.1.1 above, and the hazard cannot be eliminated, employers should assess the hazards and risks to safety and health from the thermal conditions, and determine the controls necessary to remove the hazards or risks or to reduce them to the lowest practicable level.

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<sup>3</sup> This section is drawn from Chapter 8 of the ILO code of practice *Ambient factors in the workplace* (Geneva, 2001).

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

- (i) the use of protective clothing against hazardous substances that may increase the risk from heat stress; and
- (ii) 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:
  - (a) minimizing exposure to hazardous substances so that there is less need for protective clothing; and
  - (b) changing the tasks so that work rates in hot conditions can be reduced.

5.2.3.2.3. In assessing the hazards and risks, employers should:

- (i) make comparisons with other similar workplaces where measurements have been made;
- (ii) where this is not practicable, arrange for measurements to be performed by a technically capable person, using appropriate and properly calibrated equipment; and
- (iii) seek the advice of the occupational health service or a competent body about exposure standards to be applied (see also Appendix A, section 7).

5.2.3.2.4. Measurements of thermal conditions should take account of:

- (i) all stages of work cycles and the range of temperature and humidity under which the tasks are performed;
- (ii) the range of clothing worn during the tasks;
- (iii) major changes in physical activity level (metabolic heat production); and

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- (iv) occasional tasks such as cleaning and maintenance of hot equipment, and renewal of insulation.

5.2.3.2.5. 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 Appendix A, section 7, the employer should assess control options and take effective control measures.

5.2.3.2.6. The plan for monitoring should take account of varying thermal conditions, especially seasonal variations where these are significant.

#### **5.2.3.3. Control strategies**

##### ***5.2.3.3.1. Training and information***

5.2.3.3.1.1. Workers at risk from heat should be trained, as well as their supervisors:

- (i) to recognize symptoms which may lead to heat stress, in themselves or others, and the steps to be taken to prevent onset and/or emergencies;
- (ii) in the use of rescue and first-aid measures; and
- (iii) in action to be taken in the event of increased risks of accidents at high temperatures.

5.2.3.3.1.2. Workers should be advised of:

- (i) the importance of physical fitness for work in hot environments; and
- (ii) the importance of drinking sufficient quantities of liquid.

##### ***5.2.3.3.2 Isolation, substitution, engineering controls***

5.2.3.3.2.1. Where assessment shows that the workers may be at risk from heat stress, employers should, if

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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.

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

- (i) 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;
- (ii) when this is not practicable, the employer should:
  - (a) reduce the temperature of the surface by changing plant-operating temperatures, insulating the surfaces or reducing the emissivity of the surface; or
  - (b) change plant temperature.

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

- (i) the use of radiation barriers (of low conductivity and high emissivity) between the surface and the workplace, and maintain them in a clean state;
- (ii) water-cooling the hot surfaces, where practicable;
- (iii) the use of portable reflective shielding; or
- (iv) arranging for remote control operations.

5.2.3.3.2.4. Where the assessment shows that unhealthy or uncomfortable conditions arise from increased air temperature, the employer should implement means to reduce air temperature, which may include ventilation or air cooling.

5.2.3.3.2.5. Employers should take particular care with ventilation design where work is undertaken in enclosed spaces or areas. When fail-safe systems are not in oper-

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ation, there should be adequate supervision of workers at risk to ensure that they can be removed from danger.

5.2.3.3.2.6. 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 restroom. The rest periods should be as prescribed by the competent authority and/or sufficient to allow the worker to recover (see Appendix A, paragraph 7.2). 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.

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

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

5.2.3.3.2.8. 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 capable person, taking account of the environmental conditions. A system should be installed to

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ensure that any failure of the cooling system is immediately detected and the worker removed from the environment.

5.2.3.3.2.9. For hydration maintenance, employers should make available sufficient quantities of drinking water.

5.2.3.3.2.10. 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.

5.2.3.3.2.11. Extra care should be taken when workers are required to move from a very hot working environment to a much colder one, especially when exposed to strong wind, as the “wind-chill factor” can result in exposed flesh cooling very rapidly.

5.2.3.3.2.12. Workers should be protected against the severest forms of cold stress, hypothermia and cold injury.

5.2.3.3.2.13. The core body temperature should not be allowed to fall below 36 °C (96.8 °F). Suitable protection should be provided to prevent injury to bodily extremities.

#### **5.2.3.4. Health surveillance – Secondary protection**

5.2.3.4.1. In cases where control is provided by work-rest systems (see paragraph 5.2.3.3.2.6 above) or protective clothing, workers should be examined by qualified occupational health personnel, who should determine:

- (i) their fitness for the conditions of work;
- (ii) any limitations that should be applied to their work;
- (iii) the programme of training and information for workers;

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- (iv) the measures for providing such training and information;
- (v) any pre-existing conditions among workers which might affect their tolerance to heat (such as heart disease, overweight or some skin diseases); and
- (vi) measures to minimize risks among vulnerable groups (such as older workers).

5.2.3.4.2. Workers should be allowed sufficient time to acclimatize to extremely hot environments, including major changes in climatic conditions.

#### **5.2.4. Radiation**

##### **5.2.4.1. Non-ionizing radiation**

##### **5.2.4.1.1 Hazard description**

5.2.4.1.1.1. Non-ionizing radiation is usually referred to as ultraviolet (UV), visible and infrared (IR) radiation (see definition in Appendix A, section 5).

5.2.4.1.1.2. Absorption in the UV and visible portions of the spectrum produces photochemical reactions. In the IR region, all of the absorbed radiant energy is converted into heat. Exposure to some radio-frequency and microwave radiation can result in the formation of cataracts of the eye.

5.2.4.1.1.3. Exposure of the eyes to visible and IR radiation can cause thermal injury to the retina and damage to the lens, which may result in the formation of cataracts.

5.2.4.1.1.4. The greatest source of UV radiation is solar radiation and overexposure may lead to cancer. Artificial sources include incandescent, fluorescent and discharge

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types of light sources, electric arc welding equipment, plasma torches and lasers.

5.2.4.1.1.5. Exposure of the eyes to UV radiation can result in inflammation of the conjunctiva and cornea.

##### 5.2.4.1.2. Assessment of risk

5.2.4.1.2.1. Exposure limits (ELs) for optical radiation are to be established for the various kinds of radiation. The publication, *Threshold limit values for chemical substances and physical agents and biological exposure indices* (Cincinnati, Ohio, American Conference of Governmental Industrial Hygienists, 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  $\text{mW}/\text{cm}^2$ , 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; and
- (c) ELs for IR radiation be in terms of the radiant flux density at the eye, in  $\text{mW}/\text{cm}^2$ , and unweighted for wavelength. However, for IR heat lamps there is also a limit in terms of the source's radiance.

5.2.4.1.2.2. The *Guidelines on protection against non-ionizing radiation* (Fonteny-aux-Roses, France, International Radiation Protection Association (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  $\text{J}/\text{m}^2$ , equal to the radiant flux density in  $\text{W}/\text{m}^2$  multiplied by the exposure time in seconds). The ELs



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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 are given in the practical guide, *The use of lasers in the workplace*, Occupational Safety and Health Series, No. 68 (Geneva, ILO, 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* (Geneva, International Electrotechnical Commission (IEC), 1993).

5.2.4.1.2.3. Electrical and magnetic fields are found around all equipment that passes an electric current. Static charges are created around a fixed charge, such as a visual display unit screen, or a fixed magnetic field.

5.2.4.1.2.4. Some studies have shown that exposure to magnetic fields can cause certain types of cancers and brain tumours. They can also affect a person's mood, alertness, heart function, and the immune and reproductive systems; some individuals suffer from skin irritation in the presence of electrical fields. Workers who rely on pacemakers should not be employed in areas where they may be exposed to magnetic fields, based on a risk assessment.

5.2.4.1.2.5. Unlike electric fields, magnetic fields cannot be easily screened off, as they can pass through all materials. However, the power of the field rapidly diminishes as the distance from the source of the magnetic field increases. Consequently, where risk assessment indicates that it involves an unacceptable risk, it is advisable to shut down all electrical equipment when not in use. Fixed installations which generate high-strength fields, such as transformers

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and switching stations, should be sited as far away from workstations as possible. Encapsulating the source using an alloy that is a good magnetic conductor can also reduce the effects of strong magnetic fields, as can shielding the workstation with a suitably absorbent material such as aluminium that has been welded into a continuous or single sheet.

5.2.4.1.2.6. Employers should identify all the sources and potential risk of exposure by “mapping” the field strength in the workplace.

##### **5.2.4.2. Ionizing radiation**

5.2.4.2.1. Ionizing radiation is produced when atoms break up. The energy released in this process takes a number of forms which have typical wavelength and frequency, energy and penetrating power (see definition in Appendix A, section 6). Alpha, beta and gamma radiation have sufficient energy to alter other atoms and are termed ionizing radiation.

5.2.4.2.2. All exposure to ionizing radiation should be kept as low as possible, as there is evidence that damage caused by radiation may be permanent, and that there is a significant increase in the incidence of cancer and some types of malignancies, as a consequence of even low doses of ionizing radiation.

##### **5.2.4.2.3. Hazard description**

5.2.4.2.3.1. The employer should take all necessary steps to prevent workers and members of the general public being exposed to ionizing radiation generated by any radioactive materials which may be present in any scrap metal intended to be recycled by any means.

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5.2.4.2.3.2. Materials with levels of radiation above the normal background level come particularly from: nuclear power stations; military scrap; radiographic sources; industrial radiography; medical isotopes; and other research equipment, etc. Exposure to these materials may lead to serious illnesses, including cancer.

5.2.4.2.3.3. Other sources of potential concern include: luminous gauges; gas/smoke detectors; depleted uranium ballast from old aircraft; scrap arising from offshore drilling work; and the pipes or tubes used in the extractive industries, usually referred to as “normally occurring radioactive materials (NORM)”. The inhalation of dust from furnaces may, if containing radioactive particles, cause fatal diseases.

#### **5.2.4.2.4. Assessment of risk**

5.2.4.2.4.1. Employers should take the necessary steps to protect workers from being exposed to levels of radiation above the normal background level as a result of the illegal disposal of contaminated scrap.

#### **5.2.4.2.5. Control strategies**

##### **5.2.4.2.5.1. Training and information**

5.2.4.2.5.1.1. Workers should be instructed so as to be able to operate the appropriate detection equipment and identify any suspect material.

5.2.4.2.5.1.2. Workers should be trained in the hazards of exposure to radiation and the measures to be taken if they encounter material they suspect to be radioactive.

##### **5.2.4.2.5.2. Isolation, substitution, engineering controls**

5.2.4.2.5.2.1. Employers who receive recycled scrap should be equipped with the means to detect radiation.

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Suppliers should also verify that they have the necessary systems to ensure that scrap supplies are not contaminated with radioactive material. The competent authority should determine the conditions or manner in which radioactive scrap material is present in scrap to be recycled.

5.2.4.2.5.2.2. Any materials that are suspected to be radioactive should be isolated, and plans for appropriate disposal through the requirements established by the competent authority should be strictly adhered to.

##### ***5.2.4.2.5.3. Work practices and procedural controls***

5.2.4.2.5.3.1. Large-scale recycling operations should monitor incoming raw scrap for radioactivity prior to it entering the factory. All recycling enterprises should purchase their scrap material through reliable suppliers.

5.2.4.2.5.3.2. Suspected radioactive material should not be handled but should be left in place for disposal by a competent service. The competent authority should be contacted immediately for advice on handling and disposal.

##### ***5.2.4.2.5.4. Personal protective equipment and respirators***

5.2.4.2.5.4.1. Protective equipment should be provided following advice from the competent authority.

### **5.3. Chemical hazards**

#### **5.3.1. Chemicals in the workplace**

##### **5.3.1.1. Hazard description**

5.3.1.1.1. A chemical substance is a compound or mixture which may be present in the workplace in the form of

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a liquid, solid (including particles) or gas (vapour, aerosol). These substances may present a hazard as the result of contact with the body or absorption into the body. Absorption can occur through the skin, by ingestion or by inhalation.

5.3.1.1.2. Chemicals can have acute (short-term) and/or chronic (long-term) health effects.

5.3.1.1.3. Chemicals may present a safety hazard as a result of their chemical and physical properties.

#### **5.3.1.2. Assessment of risk**

5.3.1.2.1. Workers may be exposed to chemicals actively during their use in laboratory work, or in production work by addition to the process, as well as to chemicals generated by the process or used in maintenance activities.

5.3.1.2.2. Exposure may occur passively due to the presence of chemicals in the workplace environment.

5.3.1.2.3. The advice of the competent authority and workers' representatives should be sought regarding exposure limits and other standards to be applied.

5.3.1.2.4. Material safety data sheets that include advice on the safe handling of any chemical to ensure adequate prevention and protection should be readily available. All those concerned with the storage and handling of chemicals, and with general housekeeping, should be trained and should adopt safe systems of work at all times.

5.3.1.2.5. Chemical safety data sheets should, as a minimum, meet the requirements of the competent authority and are recommended to contain the following core information:

(i) identification of manufacturer, product and ingredients;

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- (ii) physical and chemical properties, and information on the health effects, physical hazards, environmental impact and relevant exposure limits; and
- (iii) recommendations concerning safe work practices; transport, storage and handling; waste disposal; protective clothing and personal protective equipment (PPE); first aid, fire-fighting and chemical spills.

5.3.1.2.6. Labels should, as a minimum, meet the requirements of the competent authority, and are recommended to contain the following core information:

- (i) signal word or symbol; identification information, including the manufacturer, product and ingredients;
- (ii) risks and safety phrases, first-aid and disposal procedures; and
- (iii) reference to the material safety data sheets, and date of issue.

5.3.1.2.7. The ILO code of practice *Safety in the use of chemicals at work* (Geneva, 1993) provides comprehensive guidance on the above issues for chemicals and their use.

5.3.1.2.8. For further information on chemical hazards, see Appendix B.

#### **5.3.1.3. Control strategies**

##### **5.3.1.3.1. Training and information**

5.3.1.3.1.1. Employers should ensure that:

- (i) workers so involved are trained and competent in terms of proper laboratory techniques;
- (ii) workers are informed about the hazards related to the chemicals which they use, or to which they may be exposed;

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- (iii) current material safety data sheets for those chemicals found in the workplace are readily available; and
- (iv) workers and/or trained first-aid personnel are aware of emergency procedures related to exposure to hazardous chemicals.

##### **5.3.1.3.2. Isolation, substitution, engineering controls**

5.3.1.3.2.1. The employer should ensure:

- (i) proper storage of chemicals by: (a) storing separately chemicals which react with one another; (b) minimizing volumes of stored chemicals; (c) providing for containment of spills; and (d) ventilating storage areas;
- (ii) that, where hazardous chemicals are used, handled or stored, measures should be in place to minimize workers' exposure (e.g. ventilated fume hoods, remote handling);
- (iii) that, where necessary, appropriate PPE is provided and workers are trained in its correct use, and it is used properly; and
- (iv) that emergency showers and eyewash stations are available where hazardous chemicals are used and/or stored.

##### **5.3.1.3.3. Housekeeping, sanitation and personal hygiene**

5.3.1.3.3.1. Workers should wash their hands before eating and drinking, and those activities should occur in a clean environment.

5.3.1.3.3.2. Workers who smoke should not smoke or have smoking materials in the workplace, where contamination may occur. Contaminated smoking materials may in-

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crease the absorption of chemical substances. Smoking in itself may alter the health effects of a chemical substance.

5.3.1.3.3. Work clothes contaminated with a chemical substance or substances should be washed (if reusable) or disposed of (if disposable or single use) in a workplace facility.

##### **5.3.1.4. Health surveillance**

5.3.1.4.1. Where indicated by the competent authority or in legislation, appropriate biological monitoring and/or health surveillance should be in place. This monitoring should be specific to the chemical in question.

5.3.1.4.2. For further information, see section 4.6.

#### **5.3.2. Inhalable agents (gases, vapours, dusts and fumes)**

##### **5.3.2.1. Hazard description**

5.3.2.1.1. The production of non-ferrous metals involves the consumption and generation of a variety of inhalable agents including, but not limited to, gases, vapours, dusts, fumes, smokes and aerosols. These agents comprise a variety of toxicological hazards including irritants, chemical asphyxiants, fibrogens, allergens, carcinogens and systemic toxicants.

5.3.2.1.2. The pulmonary system (lungs) can be affected by exposure to harmful agents through acute (short-term) injury to lung tissue, the development of pneumoconiosis, pulmonary dysfunction and the development of lung cancer. Certain harmful agents that are inhaled through the lungs can cause target organ damage and/or systemic toxic effects. Certain asphyxiants can cause death in a matter of seconds at high concentrations.



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5.3.2.1.3. Specific agents that may be found in the non-ferrous metals industry include: primary metal fume and dust (aluminium, arsenic, beryllium, copper, lead, magnesium, manganese, nickel, nickel oxide, zinc, zinc oxide, etc.); primary metal alloys (bronze, chrome, etc.); aerosols of primary metal salts (copper sulphate, etc.); acid mists (hydrochloric, hydrofluoric, sulphuric, etc.); gases, including simple and chemical asphyxiants (carbon monoxide, chlorine, hydrogen fluoride, hydrogen sulphide, methane, natural gas, nitrogen oxides, ozone, sulphur dioxide, etc.); vapours (arsenic trioxide, diesel, gasoline, mineral spirits, polynuclear aromatic hydrocarbons, etc.); and silicate dusts (amorphous and crystalline silica, asbestos, talc – see sections 5.3.3 and 5.3.4 for a detailed review of asbestos and insulation wool, respectively). It is important to consider the solubility of metals and their compounds when addressing risk.

#### 5.3.2.2. Assessment of risk

5.3.2.2.1. The assessment of risk should begin with a review of production and maintenance processes in order to understand the content, form and volume of inhalable agents associated with the production of non-ferrous metals, including intermediates, by-products and waste. This should include information acquired from suppliers for materials brought on site through the use of material safety data sheets (see section 5.3.1.2).

5.3.2.2.2. The potential for exposure should be assessed according to the provisions of Chapter 4 of this code, the ILO codes of practice *Safety in the use of chemicals at work* and *Ambient factors in the workplace*, or another protocol of equal or greater value, such as the application of an exposure assessment protocol from a competent authority.

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5.3.2.2.3. Exposure assessment activities should be conducted by individuals with training and competence in such activities.

5.3.2.2.4. Employers should provide information to workers and their representatives regarding the risk assessment process, and inform them of the results of risk assessments.

5.3.2.2.5. When necessary, employers should seek the advice of the competent authority about exposure limits relating to inhalable agents.

#### **5.3.2.3. Control strategies**

##### ***5.3.2.3.1. Training and information***

5.3.2.3.1.1. Workers and their representatives should be made aware of the toxicological properties, safe working procedures, protective equipment and emergency procedures necessary to eliminate exposure. Where it is not possible, exposure to harmful inhalable agents with which they work or may come in contact should be minimized.

5.3.2.3.1.2. Training should be provided in advance of the work, including production or maintenance process changes that result in the use or generation of different inhalable agents.

5.3.2.3.1.3. Training should specify special precautions to be taken for workers who perform work in confined spaces that might contain harmful inhalable agents. See section 5.4.1 for additional information on safe work practices involving confined spaces.

##### ***5.3.2.3.2. Isolation, substitution, engineering controls***

5.3.2.3.2.1. Employers should develop and implement engineering controls for harmful inhalable agents. Such

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controls include, but are not limited to: the substitution of more harmful agents by less harmful agents; isolating processes that generate such airborne contaminants; and the use of local and general ventilation systems.

5.3.2.3.2.2. See the ILO codes of practice *Safety in the use of chemicals at work* and *Ambient factors in the workplace* for additional direction in the development and implementation of engineering controls.

##### **5.3.2.3.3. Work practices and procedural controls**

5.3.2.3.3.1. When engineering controls are not feasible or sufficiently effective to ensure that exposure to inhalable agents is maintained at or below exposure limits, work practices and procedural controls should be applied. These might include, but are not limited to: altering temperature, pressure and other process settings; and minimizing the length of time that workers are potentially exposed to inhalable agents.

5.3.2.3.3.2. See the ILO codes of practice *Safety in the use of chemicals at work* and *Ambient factors in the workplace* for additional direction in the development and implementation of engineering controls.

##### **5.3.2.3.4. Housekeeping, sanitation and personal hygiene**

5.3.2.3.4.1. The harmful effects of many inhalable agents may be made worse when inhalation occurs simultaneously with smoking. Areas should be designated for smoking that are separate from inhalable agents, where appropriate.

5.3.2.3.4.2. Employers should avoid the accumulation of toxic metal dusts or fumes on surfaces where they may be

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deposited. Surface contamination may lead to secondary exposure through ingestion.

##### **5.3.2.3.5. *Personal protective equipment and respirators***

5.3.2.3.5.1. When work practices and procedural controls are not feasible or sufficiently effective to ensure that exposure to inhalable agents is maintained at or below exposure limits, or in the event of an emergency, appropriate respiratory protection should be utilized.

5.3.2.3.5.2. See section 4.9 for a detailed review of the use of respiratory protection and other PPE.

5.3.2.3.5.3. At a minimum, unprotected exposure to inhalable agents should be controlled at a concentration that is no higher than the appropriate exposure limits.

5.3.2.3.5.4. In the event of emergency conditions such as fires, explosions, process containment failure and the accumulation of poisonous and asphyxiating gases, emergency respiratory protection should be made available to workers and their representatives. The respiratory protection should be appropriate to the hazard and risk in question. When the hazard and risk cannot be assessed with sufficient accuracy to define the appropriate level of respiratory protection, employers should make positive pressure air-supplied respiratory protective devices available.

##### **5.3.2.4. Health surveillance**

5.3.2.4.1. See section 4.6 for information on health surveillance.

5.3.2.4.2. Health service personnel should consult Appendices A and B of this code for additional relevant information.

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### **5.3.3. Asbestos**

#### **5.3.3.1. Hazard description**

5.3.3.1.1. Exposure to asbestos (see “Definitions”, pages 5-10) may cause diseases of the respiratory and digestive tracts, through inhalation or ingestion, and may cause secondary disease in a number of vital organs.

5.3.3.1.2. The effects of exposure to asbestos may not become apparent for two or three decades, or even longer. However, the diseases caused by exposure to these substances, such as asbestosis and mesothelioma, once diagnosed are irreversible, disabling and frequently fatal.

#### **5.3.3.2. Assessment of risk**

5.3.3.2.1. If a worker could be exposed to asbestos, the employer should develop and implement an exposure control plan.

5.3.3.2.2. The employer should ensure that the administration of this plan is undertaken by a competent person in accordance with the requirements of the competent authority.

5.3.3.2.3. The employer should ensure that an inventory of all asbestos-containing materials in the enterprise is prepared and kept current, and that these materials are identified by signs, labels or, when this is not practicable, other effective means.

5.3.3.2.4. The employer should ensure that a risk assessment on asbestos-containing material identified in the inventory is conducted by a competent person. Regard should be given to the condition of the material, its friability, accessibility, and likelihood of damage, and the potential for fibre release and exposure of workers.

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### **5.3.3.3. Control strategies**

5.3.3.3.1. The employer should ensure that asbestos-containing material is controlled by removal, enclosure or encapsulation, to prevent the release of asbestos fibre.

5.3.3.3.2. The employer should not allow any work that would disturb asbestos-containing material, unless necessary precautions have been taken to protect workers.

5.3.3.3.3. If a worker may be exposed to asbestos, the employer should ensure that:

- (i) a walk-through survey is conducted to assess the potential for exposure;
- (ii) if the survey reveals that workers may be at risk of exposure to asbestos, air sampling is conducted to assess the potential for exposure;
- (iii) workplace exposure monitoring and assessment are conducted using occupational hygiene methods acceptable to the competent authority; and
- (iv) the results of the monitoring and assessment, or a summary of the results, are provided to the workers and their representatives without undue delay.

5.3.3.3.4. The employer should retain all records of asbestos-containing materials inventories and risk assessments, inspections, and air monitoring results.

### **5.3.3.3.5. Training and information**

5.3.3.3.5.1. The employer should ensure that any worker who may be at risk of exposure is adequately instructed and trained in:

- (i) the hazards of asbestos;
- (ii) the means of identifying asbestos-containing material;

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- (iii) the work procedures to be followed, which should be approved by the competent authority, and provided to the workers and their representatives in written or other suitable form;
- (iv) the correct use of the operation of engineering controls and PPE; and
- (v) the purpose and significance of any required health monitoring.

##### **5.3.3.3.6. Isolation, substitution, engineering controls**

5.3.3.3.6.1. The employer should ensure that procedures for handling or using asbestos-containing material prevent or minimize the release of asbestos fibres. The procedures should address:

- (i) the containment of asbestos;
- (ii) the control of the release of asbestos;
- (iii) the provision, use and maintenance of PPE and clothing;
- (iv) means of decontamination of workers; and
- (v) the removal of asbestos waste and clean-up of asbestos waste material.

5.3.3.3.6.2. The procedures should provide the workers with task-specific work direction that addresses hazards and necessary controls.

5.3.3.3.6.3. The employer should substitute asbestos by less hazardous materials. If such substitution is not practicable, the employer should document the reasons why substitution cannot be made and make this documentation available to the workers, their representatives and the competent authority.

5.3.3.3.6.4. The employer should establish and ventilate containment areas where asbestos may be present, so that:

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- (i) air flows only from clean outside areas into the contaminated area; and
- (ii) exhaust air from the contaminated area is directed through a high-efficiency particulate air (HEPA) filter.

5.3.3.3.6.5. The employer should provide local exhaust ventilation with exhaust air discharge through a HEPA filter for all dust-producing activities outside containment areas where asbestos-containing dust is present.

5.3.3.3.6.6. Asbestos-containing material that is to be disturbed should be effectively wetted before and during the work, whenever practicable.

##### ***5.3.3.3.7. Housekeeping, sanitation and personal hygiene***

5.3.3.3.7.1. The employer should prevent the spread of asbestos dust and debris to other work areas.

5.3.3.3.7.2. The employer should remove all asbestos dust and debris, including contaminated protective clothing and clean-up equipment, by placing this material in sealed containers that are clearly labelled as containing asbestos.

5.3.3.3.7.3. Clean-up should be undertaken at the end of each work shift, or at the completion of work involving asbestos, whichever occurs first.

5.3.3.3.7.4. The employer should provide decontamination and washing facilities, and facilities that will enable the workers to eat and drink in a secure environment free from contamination.

##### ***5.3.3.3.8. Personal protective equipment and respirators***

5.3.3.3.8.1. The employer should supply respiratory protection specifically designed to prevent exposure to asbestos and ensure that workers wear it.



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5.3.3.3.8.2. The employer should ensure that all workers wear protective clothing that is made of material resistant to penetration by asbestos fibres, fits snugly at the neck, wrists and ankles, and covers the head and feet as well as the body.

5.3.3.3.8.3. The employer should replace or repair any torn or damaged protective clothing immediately.

5.3.3.3.8.4. Before the removal of all protective clothing and equipment, the employer should ensure that the worker cleans this clothing and equipment with a damp cloth, or a vacuum cleaner equipped with a HEPA filter exhaust.

5.3.3.3.8.5. The employer should ensure that a worker removes protective equipment and clothing before leaving the containment area or any workplace exposed to asbestos dust.

5.3.3.3.8.6. The employer should ensure that all contaminated clothing, if it is to be reused, is cleaned with a vacuum cleaner fitted with a HEPA filter exhaust and placed in a water-soluble plastic bag, which is sealed and clearly labelled before being sent to a laundry facility.

5.3.3.3.8.7. The employer should ensure that the laundry facility is informed of the hazards of asbestos and the necessary precautions for handling such clothing.

#### **5.3.4. Insulation wools**

5.3.4.1. The term “insulation wool” refers to that group of products that includes glass wool, rock wool, refractory ceramic fibres (RCFs), refractory fibres other than RCFs and special-purpose glass fibres.

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### **5.3.4.2. Hazard description**

5.3.4.2.1. Insulation wools have mechanical irritant properties and pose a threat of disease to the eyes, skin and upper respiratory tract. However, some of the effects of exposure to insulation wools may not become apparent for two or three decades, or even longer.

5.3.4.2.2. RCFs, particularly those containing amorphous silica, have the potential to be converted to crystalline silica where they have been exposed to heat in excess of 1,000 °C (1,800 °F), for an extended period of time. Where RCFs have been exposed to heat, they should be treated with the same precautions as if they had undergone conversion to crystalline silica.

### **5.3.4.3. Assessment of risk**

5.3.4.3.1. Employers in the user and removal industries, as well as manufacturers, should develop and implement safe work practices which, as a minimum, conform to the requirements laid down by the competent authority, taking into account the recognized hierarchy of preventive and protective measures. Employers should be provided with assistance by the competent authority whenever practicable.

5.3.4.3.2. Manufacturing employers should ensure that the design, installation, operation and maintenance of manufacturing processes, and the management of wastes within the manufacturing facility, result in the lowest practicable release of fibres and dust into the working environment.

5.3.4.3.3. Employers using insulation wools should, as far as practicable, select appropriate products or handling methods so as to minimize the generation of fibres and dust,

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and should keep themselves informed regarding the development of changing insulation technology.

5.3.4.3.4. Employers should assess the hazards and risks, inform the workers about them and provide appropriate supervision. They should ensure that all workers involved in the production and handling of insulation wools, including supervisors, receive adequate instructions and training in safe work practices, and, where necessary, in the selection, wearing and maintenance of PPE.

##### **5.3.4.4. Control strategies**

5.3.4.4.1. Employers should provide the equipment, including PPE, necessary for the production and handling of insulation wools, and offer appropriate washing and changing facilities for workers exposed to insulation wools.

5.3.4.4.2. Employers should ensure that exposures to fibres and dust are kept as low as reasonably achievable, and at least below the exposure limits set by the competent authority. Unnecessary exposures should be avoided.

5.3.4.4.3. Employers should ensure appropriate site maintenance, removal and disposal procedures which minimize the generation of fibres and dust. Disposal should be carried out in accordance with the requirements laid down by the competent authority.

5.3.4.4.4. Whenever two or more employers undertake activities simultaneously at one workplace, they should cooperate in applying these provisions, without prejudice to the responsibility of each employer for the safety and health of workers in his or her employment. Insulation contractors should inform other workers on the job site, including supervisors, regarding the presence of insulation wools brought on to the site by the insulation contractor.

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5.3.4.4.5. Employers should initiate and maintain a process of consultation and cooperation with workers and their representatives concerning all aspects of safety in the use of insulation wools specified here and in the ILO code of practice *Safety in the use of synthetic vitreous fibre insulation wools (glass wool, rock wool, slag wool)* (Geneva, 2001), and in particular as regards the preventive and protective measures listed in the previous paragraphs. This process should be carried out within the framework of safety and health committees, where they exist, or through another mechanism determined by the competent authority or by voluntary agreement.

5.3.4.4.6. Manufacturers should promote an ongoing process of product improvement, and the establishment of databases containing validated measurements of exposure levels in different working situations where the materials that they manufacture are used.

5.3.4.4.7. Manufacturers should support product development that addresses issues of potential health concern, such as the risk of a release of respirable fibres and dust particles, the biopersistence properties, and the chemical additives.

5.3.4.4.8. Manufacturers should ensure that the products can be transported, stored, used and disposed of with the minimal release of fibres and dust. Where practicable, manufacturers should supply pre-cut, ready-to-install products.

5.3.4.4.9. Material safety data sheets and labels, as well as other product information on safety and health in the use of insulation wools, conforming to the requirements of the competent authority, should be prepared by manufacturers and made available to suppliers and users. The production

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of material safety data sheets in electronic format should be encouraged.

5.3.4.4.10. Manufacturers should initiate and maintain a process for regular consultations with the affected parties concerning health, safety and working environment issues relating to product development, and as regards the extent and effectiveness of the application of the guidance and instructions given for the use of their products.

5.3.4.4.11. Suppliers and importers, as the link between manufacturers and users, should ensure that the information and instructions of the manufacturers are transmitted to their customers. Any repackaging by the supplier should meet the requirements set out for manufacturers on packaging, storage, transport, labelling, material safety data sheets and product information.

5.3.4.4.12. Building clients, designers and specifiers should consider the potential for fibre and dust generation during installation, use, maintenance and removal whenever designing, selecting or specifying the use of insulation materials.

5.3.4.4.13. Designers and specifiers should keep themselves informed regarding the development of appropriate products in respect of safety and health, as materials technology improves. Building clients undertaking insulation work should seek information about the development of insulation technology and materials.

5.3.4.4.14. Specifiers should choose insulation wools which: (a) meet the necessary insulation requirements; and (b) are least likely to result in the generation of fibres and dust because of their intrinsic properties, method of use, and pre-supply preparation. Specifiers should aim to use

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construction techniques that minimize cutting and handling of insulation wool products on site.

5.3.4.4.15. Building clients, designers and specifiers should ensure that all requirements of the competent authority are included in specification and tender documents. They should maintain records of the location and type of insulation used so as to provide the necessary information to those who may have potential for exposure in the future.

5.3.4.4.16. Building clients and main contractors should always give preference to contracting insulation firms which conform to the requirements of the competent authority.

### **5.4. Safety hazards**

#### **5.4.1. Confined space**

##### **5.4.1.1. Hazard description**

5.4.1.1.1. A confined space is one that is large enough for the worker to enter bodily, has limited or restricted means of entrance or exit and is not designed for continuous employee occupancy. Examples of temporary occupancy might entail a worker performing repairs on a furnace or servicing a fuel tank or trailer, sump, silo or bunker. Employers should be especially vigilant about all safety and health hazards that may exist in a confined space. Confined spaces require additional safety and health precautions because their configurations hinder the activities of any workers who must enter, work in and exit from them. In addition, many fatalities occur to rescue personnel who respond without adequate protection.

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##### **5.4.1.2. Assessment of risk**

###### **5.4.1.2.1. The employer should:**

- (i) seek the advice of the competent authority or other occupational safety and health service regarding compliance with national legislation and regulation;
- (ii) identify, test and inspect the confined spaces in the workplace and determine if workers are required to enter and work in them;
- (iii) where entry is not required, prevent unauthorized or inadvertent entry into a confined space by posting warning signs, locking and securing, or other measures as necessary, to ensure that workers do not enter without proper protection;
- (iv) where entry is required by a worker, fully characterize, through testing and inspection, all existing and potential hazards in the confined space (hazards can be classified as mechanical, oxygen depletion, flammable or combustible vapours and gases, and toxic gases and vapours), including blanking off or bleeding all supply systems to the confined space; and
- (v) where there is reason to believe that conditions have changed, re-evaluate the confined space.

##### **5.4.1.3. Control strategies**

###### **5.4.1.3.1. Training and information**

###### **5.4.1.3.1.1. The employer should:**

- (i) inform and train workers entering and working in the confined space of the hazards, protective measures and emergency rescue procedures; and

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- (ii) inform the other employers (contractors) on site that the workplace contains hazardous confined spaces and of any precautions and protective measures that are necessary to protect workers in or near the space.

##### ***5.4.1.3.2. Isolation, substitution, engineering controls***

5.4.1.3.2.1. The employer should:

- (i) where entry is required by a worker, ensure that all hazards in the space are eliminated or controlled, or provide adequate PPE to ensure adequate protection of the worker; and
- (ii) purge, make inert, flush or ventilate the hazardous confined space, as necessary, to eliminate or control the hazards.

##### ***5.4.1.3.3. Work practice and procedural controls***

5.4.1.3.3.1. The employer should:

- (i) develop a comprehensive programme to address work in a confined space; and
- (ii) be aware of any confined-space work to be performed and implement procedures to monitor work progress and work completion.

5.4.1.3.3.2. In the non-ferrous metals industries, many foundries have confined spaces where concentrations of harmful agents in the air may be significantly higher than the permissible exposure levels if controls in the workplace are inadequate. Both furnace operators and maintenance personnel are at increased risk of exposure in confined spaces.

5.4.1.3.3.3. Potentially hazardous confined spaces should be clearly marked with warning notices prohibiting unauthorized entry, as serious injury or loss of life could occur if safe systems of work are not followed.



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5.4.1.3.3.4. Because of the explosion hazard inherent in some confined spaces, compressed air should not be used for artificial ventilation if there is a potential for sources of ignition. Compressed gas cylinders should be excluded from these spaces for the same reason.

5.4.1.3.3.5. All potential sources of ignition should be prevented from entering a confined space that may contain a flammable/combustible atmosphere. In particular, the precautions should include clothing, tools, lighting, smoking materials and electrical apparatus.

5.4.1.3.3.6. Where a potential for a flammable/combustible atmosphere exists, only approved electrical apparatus and fixtures should be used.

5.4.1.3.3.7. A system of tags should be used to ensure that no personnel or equipment remain in the confined space before any openings are resealed or power and process piping reconnected.

5.4.1.3.3.8. Employers should have developed emergency procedures, including provision for rescue from the hazardous confined space, to address any foreseeable accidents.

5.4.1.3.3.9. Workers in the hazardous confined space should be closely monitored by personnel outside the space to ensure that safe entry conditions are maintained. Where necessary, such personnel can effect a rescue of worker(s) from the space.

#### **5.4.1.3.4. Personal protective equipment and respirators**

5.4.1.3.4.1. Employers should provide workers entering a confined space with appropriate respirators and PPE

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to control hazards in the confined space, and training on PPE use in confined spaces.

##### **5.4.1.4. Health surveillance**

5.4.1.4.1. Employers should provide the workers and their representatives with the results of any testing conducted in the hazardous confined space as requested, or in compliance with the requirements of the competent authority.

##### **5.4.2. Control of hazardous energy**

5.4.2.1. The non-ferrous metals industry regularly uses different sources of energy (electric, mechanical, hydraulic, pneumatic, etc.). The safe control of energy should be addressed by procedure and carried out by appropriately trained personnel in accordance with the nature of the energy source and the characteristics of the facilities. Adequate PPE should be provided to the personnel concerned. Energy sources for equipment should be turned off or disconnected, and the switch locked or labelled with a warning tag.

5.4.2.2. Employers should identify and implement specific procedures for the control of hazardous energy. These procedures should include:

- (i) preparation for shutdown;
- (ii) shutdown;
- (iii) equipment isolation;
- (iv) lock-out or tag-out application;
- (v) release of stored energy and safe positioning of workers;
- (vi) verification of isolation; and
- (vii) removal of lock-out/tag-out device.

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5.4.2.3. Workers working in the hazard area should be trained in the hazard and the protective measures in place.

5.4.2.4. Contractors working on equipment or systems should be informed of lock-out/tag-out procedures and required to follow the predominant lock-out/tag-out procedures in the facility.

5.4.2.5. All electrical installations should be appropriately designed and should include appropriate protection systems, such as automatic shut-off systems and emergency controls.

5.4.2.6. Facilities should be installed and used in accordance with the requirements of the manufacturer and in compliance with the competent authority.

5.4.2.7. The energy distribution facilities should be appropriately situated and protected, and access limited to authorized personnel only.

5.4.2.8. Energy sources and facilities should be appropriately labelled.

5.4.2.9. A risk assessment should be conducted before isolating the energy source to ensure that the consequences have been evaluated.

5.4.2.10. All facilities and equipment undergoing servicing, renovation or maintenance should be appropriately isolated, locked out and labelled to ensure that all persons are protected.

#### **5.4.3. Internal transport**

##### **5.4.3.1 Hazard description**

5.4.3.1.1. Internal transport, such as transport of raw materials, intermediates, products, waste and people, has

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the potential to cause injuries to workers and their representatives, as well as damage to the workplace and the environment.

5.4.3.1.2. The hazards can be caused by interaction between vehicles, vehicles and other objects and personnel, or by loads falling off or from the vehicle.

##### **5.4.3.2. Control strategies**

###### **5.4.3.2.1. Training and information**

5.4.3.2.1.1. Operators of vehicles should receive and maintain adequate training and the required certification according to the regulations established by the competent authority.

5.4.3.2.1.2. Operators of certain types of vehicles may require regular medical surveillance.

5.4.3.2.1.3. Operators should have the necessary knowledge of the hazards and potential risks concerning the transportation of the cargo.

###### **5.4.3.2.2. Prevention and control**

5.4.3.2.2.1. Transport routes should be planned and constructed to minimize the risk of collision and with sufficient safe clearance to allow for aisles and turns, or other types of control area. Where appropriate, maps showing the proposed route should be provided.

5.4.3.2.2.2. Transport routes should be clear of obstructions and, where possible, without irregular surfaces.

5.4.3.2.2.3. Walkways and transport routes should be visibly marked and segregated to the greatest extent possible.

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5.4.3.2.2.4. The safe operating speed for vehicles should be posted and enforced.

5.4.3.2.2.5. Vehicles should be used and maintained in accordance with the requirements of the competent authorities and, as appropriate, be equipped with safety devices such as fire-fighting equipment and warning devices for reversing operations.

5.4.3.2.2.6. The operator should be protected from cargo, such as molten metal splashes, chemicals and unsecured cargo.

5.4.3.2.2.7. Loads should be lowered slowly and smoothly.

5.4.3.2.2.8. Vehicles operating in polluted atmospheres should be equipped with ventilated cabins.

5.4.3.2.2.9. Vehicles should be kept clean and tidy, and operators should report critical faults and deficiencies immediately to the employer.

5.4.3.2.2.10. Forklift controls should be designed to stop if released.

5.4.3.2.2.11. Forklift trucks used to transport molten material should have solid or water-filled tyres, and their fuel tanks should be protected and insulated from ignition. The driver's station should have rigid splashguards fitted.

5.4.3.2.2.12. Lifting hooks should be made of steel that is not prone to hydrogen embrittlement and should be shielded from radiant heat.

5.4.3.2.2.13. Workstations should not be located underneath the path of molten material.

5.4.3.2.2.14. With regard to overhead ladles, no fixtures that might cause spillage en route should be within a

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short distance (approximately 50 cm) of their external limit of travel.

#### **5.4.4. Work equipment and machinery guarding**

##### **5.4.4.1. Hazard description**

5.4.4.1.1. The use of work equipment, including machinery, results in a number of accidents, many of which are serious and some fatal. Of the many factors that can cause risk, particular areas of concern include:

- (i) a lack of guards or inadequate guards on machines, which can lead to accidents caused by entanglement, sheering, crushing, trapping, cutting, etc.;
- (ii) failure to keep guards, safety devices, controls, etc., properly maintained so that the machines or equipment become unsafe; or
- (iii) failure to provide the right information, instruction and training for those using the equipment.

##### **5.4.4.2. Role of employer**

5.4.4.2.1. Controlling risks often means guarding those parts of machines and equipment that could cause injury. Many accidents happen because of the failure to select the right equipment for the work to be done. Planning ahead can control risks and ensure that suitably protected equipment or machinery is available. Moreover, there are many machines, parts of machines or parts of work equipment which if not properly guarded can cause injury to the operator. The objective is to make sure that machines are made safe by eliminating sources of harm. However, this is not always possible; therefore, risks have to be controlled.

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5.4.4.2.2. Employers should be advised that:

- (i) fixed guards should be used wherever possible, and properly fastened in place with appropriate fasteners including, but not limited to, screws or nuts and bolts which need tools to remove them;
- (ii) if workers need regular access to parts of the machine and a fixed guard is not possible, an interlocked guard should be used. This will ensure that the machine cannot start before the guard is closed and will stop if the guard is opened while the machine is operating. If access is required to parts that are guarded, the machinery should be shut down;
- (iii) they should establish systems for inspection to ensure that guards are properly maintained and defects are rectified; and
- (iv) workers should be trained to operate equipment before they are directed to do so.

5.4.4.2.3. Other control measures to be aware of include the following:

- (i) risks can be reduced by the careful selection and location of controls for machinery and equipment;
- (ii) it is appropriate to ensure that hand tools may be operated safely;
- (iii) regular maintenance of machinery and equipment is required to ensure that they are in a safe condition;
- (iv) maintenance work on energizing equipment should be carried out safely; and
- (v) workers should be instructed and trained, and their level of skill and training should be controlled thereafter.

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### **5.4.4.3. Role of workers**

#### **5.4.4.3.1. Workers should:**

- (i) know how to operate the machine (following the operating manual instructions), including the emergency stopping procedures, before commencing operation;
- (ii) receive relevant training on potentially dangerous machinery before being allowed to operate it alone;
- (iii) never use a machine unless they are trained to do so;
- (iv) check that the guards are in position and all protective devices are working; and
- (v) immediately stop the machine if it is not working safely or if any guards or protective devices are faulty, and inform the supervisor as soon as possible.

### **5.4.5. Cranes and hoists**

5.4.5.1. All machinery used to lift and/or transport equipment, materials, molten metal or slag must be designed, constructed and erected, inspected, maintained and operated as specified by the manufacturer. It must meet all the standards specified by the competent authority to enable it to fulfil all its designated tasks, without posing any foreseeable risk to those who work within its designated scope of operations or operate the machines.

5.4.5.2. The rated capacity and/or legible load chart, where appropriate, of a crane or hoist should be permanently marked on the structure and clearly visible. The rated capacity should not be exceeded.

5.4.5.3. The rated capacity of a hoist should not exceed the capacity of the structure supporting the hoist.

5.4.5.4. Cranes and hoists should be regularly inspected and maintained to ensure that every component is capable of carrying out its original design function.



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5.4.5.5. A crane or hoist should not be used until any condition that could endanger workers is remedied. All repairs to load-bearing equipment should be certified by a professional engineer in accordance with the original design and safety standard, and the requirements of the competent authority.

5.4.5.6. All cranes or hoists with a boom that is movable in the vertical plane should have a device that can be clearly read by the operator, to indicate the boom angle, if the rated capacity is affected.

5.4.5.7. All modifications that affect the rated capacity of a crane or hoist should be assessed, and the rated capacity adjusted by the original equipment manufacturer or a professional engineer.

5.4.5.8. There should be a safe means of access and egress to the operator's position and to maintenance locations for all cranes and hoists.

5.4.5.9. If a normal safe means of egress is not always available to the operator, then an alternative safe means should be provided to get from the operating position to a safe area in the event of a power failure or other emergency.

5.4.5.10. An effective audible warning device should be installed on a crane or hoist. The crane or hoist operator should sound a warning signal when it is necessary to alert workers.

5.4.5.11. A crane or hoist handling molten metal or slag should have two holding brakes on the hoist mechanism.

5.4.5.12. All controls on a crane or hoist should be clearly identified and should return to neutral when released, and an automatic braking system should be activated.

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5.4.5.13. The operator of a crane or hoist should be protected against hazardous conditions such as airborne contaminants, falling or flying objects, and excessive heat or cold.

5.4.5.14. The operator's seat on a crane or hoist should be of a design that allows the operator to operate the equipment safely.

5.4.5.15. All the hooks, hook guards/latches, wire ropes, chains and other attachments and fittings that may be safety critical should be maintained and inspected on a regular basis.

5.4.5.16. Following the release of a crane or hoist from maintenance, it should be inspected by a competent person to verify that it can continue to operate at its original safe working load.

5.4.5.17. Transport routes for molten metal should be clear of obstructions, without irregular surfaces, and be level. If irregular surfaces are inherent in the layout of the plant, the equipment should be designed to cope with this.

5.4.5.18. The speed of the transporting vehicle or device should be limited (e.g. not to exceed walking pace).

5.4.5.19. The load should be lowered slowly and smoothly (e.g. not more than 20 cm/sec.).

#### **5.4.6. Falling objects**

5.4.6.1. Falling materials are a dangerous hazard. The employer should control the risk by adopting the following measures to protect people working in any area where there is a danger of injury that may be caused by falling material:

- (i) take all necessary steps to prevent materials or objects falling;

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- (ii) keep areas clean, in good working order and well maintained to prevent the accumulation of process materials that could subsequently fall;
- (iii) ensure the use of covered walkways or alternative safeguards such as safety nets; and
- (iv) schedule required overhead maintenance when there is the fewest number of people present and ensure that access to the area is prevented by cordoning off all areas where there is a potential risk from falling objects.

5.4.6.2. If people are required to have access to any area where there is a danger of injury from falling material, extreme caution should be taken to avoid injury. All such people should be provided with appropriate PPE, such as hard hats, etc. The use of such equipment should be mandatory.

## **6. Furnaces**

### **6.1. General**

6.1.1. The non-ferrous metals industries use a range of furnaces including electric furnaces, arc furnaces, induction furnaces, crucible furnaces, roasting ovens, simple blast furnaces or, more commonly, reverberatory-type furnaces.

6.1.2. Only authorized persons should be allowed near furnaces.

6.1.3. There should be suitable and sufficient general and local exhaust ventilation with dust- and fume-collecting devices incorporated into the design of the exhaust ventilation systems.

6.1.4. The effectiveness and adequacy of general and local exhaust-ventilation systems to remove fumes and gases from the furnace area should be tested regularly. Collection bags for dusts should be replaced when indicated.

6.1.5. Ultraviolet (UV) and/or infrared light-resistant goggles or face shields should be provided where there is a requirement for the authorized visual inspection of furnaces.

6.1.6. Continuous detectors should be installed to provide early warning of raised levels of dangerous gases.

6.1.7. Positive pressure self-contained breathing apparatus should be available to enable rapid rescue in the event of a build-up of dangerous gases. The breathing apparatus should be checked and maintained regularly, and should only be used by people who have been trained to do so.

6.1.8. People working in and around the furnace area should be provided with suitable personal protective equipment (PPE) to protect them against molten metal burns, noise, and physical and chemical hazards (see also

Chapter 5). PPE should be to molten metal standard for casters and others exposed to molten metal. Specific PPE should include, but not be limited to:

- (i) molten metal resistant jackets and trousers;
- (ii) face shields or vented goggles;
- (iii) molten metal resistant gloves;
- (iv) safety footwear insulated against heat;
- (v) respiratory protective equipment;
- (vi) protective helmets; and
- (vii) hearing protection.

### **6.2. Preventing fires and explosions**

6.2.1. Fires and explosions in furnaces most often result from water coming into contact with molten metal at temperatures up to 2,000 °C. The water may be present in scrap materials or damp moulds.

6.2.2. Fires and explosions in furnaces can also result from the ignition of volatile materials and fuels.

6.2.3. The most hazardous procedures are during the firing-up and shutting-down procedures. Gas-fired furnaces should have safeguards to ensure that unspent fuel does not accumulate and ignite. The fuel supply to gas- or oil-fired furnaces should be fitted with an automatic shut-off mechanism.

6.2.4. Operators should be trained in safe systems of work. The building should be designed to be non-combustible, with automatic fire suppression engineered or designed into the process wherever possible.

6.2.5. Risk assessments should be carried out to consider the potential dispersal of toxic chemicals from

## **Safety and health in the non-ferrous metals industries**

non-furnace processes and combustion products, and the potential impact of an explosion on other plant or premises.

6.2.6. Regular safety audits should be undertaken to ensure that hazards are clearly identified and risk-control measures maintained at an optimum level.

6.2.7. Refractories (e.g. crucibles, troughs, ladles) and tools should be preheated and dried before use to minimize the risk of explosion. Refractory linings should be regularly inspected for wear.

### **6.3. Lighting furnaces**

6.3.1. Before a furnace is lit, fittings and appliances should be inspected to ensure that they are in working order. Particular attention should be paid to the furnace control settings, the air supply, the emission stacks, the fuel supply and its associated pipe work.

6.3.2. Hand-held torches used to light small furnaces should have a handle of adequate length, and the operator should use a suitable protective shield and heat-insulated gloves to prevent possible burns.

6.3.3. A slight draught should be allowed via the air supply to support ignition when the fuel has been switched on and the flame applied.

6.3.4. People responsible for operating the furnace should keep a close watch on the fuel supply.

### **6.4. Dusts and fibres**

6.4.1. When a furnace is stripped for maintenance purposes, particular care should be taken to avoid inhaling dusts or fibres from the insulating material. Dust and fume collectors should be incorporated into the furnace design

## **Furnaces**

(see section 5.3.2. Further information on working with mineral wool fibres can be found in the ILO code of practice *Safety in the use of synthetic vitreous fibre insulation wools (glass wool, rock wool, slag wool)* (Geneva, 2001)).

### **6.5. Maintaining tap holes**

6.5.1. Tap holes should be checked regularly for damage and build-up of corundum, to prevent molten metal splashes.

### **6.6. Preventing slips and falls in furnace areas**

6.6.1. Floors in furnace areas should be of robust construction, using non-combustible materials.

6.6.2. Floor surfaces should be maintained regularly, and kept clean and free of oil spills and obstructions.

6.6.3. Floors adjoining tracks in the foundry should be level with the tops of the track rails.

6.6.4. Steel floor plates should be made slip resistant through the use of appropriate materials or surface design.

6.6.5. Pits and other floor openings should be covered or cordoned off with clear warning signs when not in use. Such areas should always be well lit.

6.6.6. Furnaces with elevated points of access should be provided with suitable platforms or walkways equipped with handrails and protective barriers.

6.6.7. Platforms and walkways should be accessible via permanent, fire-resistant elevators, stairways or ladders.

6.6.8. Open-mesh walkways or platforms should be constructed so that any apertures in the mesh are small enough to prevent heavy objects from falling through, resulting in injury to people below.

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6.6.9. Platforms, walkways and stairways with open sides should be provided with railings with panelling up to the height of the railings. Alternatively, they should have kick boards or toe boards extending part-way up the railings.

6.6.10. Hinged covers should be provided at openings in elevated walkways or platforms, and should be kept closed when not in use and suitably guarded when in use.



## **7. Handling molten metal, dross or slag**

### **7.1. Hazard description**

7.1.1. Hot dross processing is used to separate metals from hot slag by rotating the mixture in a refractory-lined barrel and extracting the metal through a hole in the base.

7.1.2. In non-ferrous metals foundries, metal is heated to its molten state, poured and cast using different moulds and processes. Skin and eye contact with splashes of molten metal results in varying-thickness skin burns and eye damage. There is also a range of physical, safety, chemical and biological hazards for different types of casting processes (see table 7.1).

### **7.2. Assessment of risk**

7.2.1. The likelihood of skin and eye injury in the handling of molten metal depends on an assessment of the different stages in the process. This includes the integrity, stability and use of the furnace and transport ladles, the nature and use of vehicle/crane transport, and the systems in place for pouring molten metal.

### **7.3. Control strategies**

#### **7.3.1. Training**

7.3.1.1. Personnel handling molten metal should have been trained in the proper procedures to adopt, and the relevant safety and health precautions, including use of appropriate personal protective equipment (PPE).

7.3.1.2. Completion of training should be documented, and training repeated as necessary.

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Table 7.1. Detailed hazards relative to each casting process

Hazard	Sand casting	Die casting	Investment casting	Continuous casting
<b>Physical</b>				
HAVS	xxx	x	xx	—
Noise	xxx	xx	xx	—
Molten metal splashes	xxx	xxx	xxx	xxx
Radiation (UV, IR)	xx	xx	x	xx
<b>Chemical</b>				
Chemicals	xxx	x	xx	xxx
Dust	xxxx	x	xxx	xxx
Metal fumes	xxxx	xx	xxx	xxx
Binder fumes	xxx	xx	—	—
Mineral fibres in refractories	xxx	xxx	xxx	xxx
<b>Biological</b>				
Legionella	xx	xxx	x	x
<b>Safety</b>				
Guarding	xxx	xxxx	xx	xxx
Manual handling	xxx	xxx	xxxx	xxx
Slips, falls, etc.	xxx	xxx	xxx	xxx
Mechanical lifting	xxxx	x	x	xxx
Transport accidents	xxxx	xxxx	xxxx	xxxx
Key: HAVS = hand-arm vibration syndrome. — = negligible hazard. x = minor hazard. xx = moderate hazard. xxx = definite hazard. xxxx = extreme hazard.				

#### **Handling molten metal, dross or slag**

7.3.1.3. Persons who are untrained should not be employed in the transport of molten metal.

### **7.4. Work practices**

#### **7.4.1. General provisions**

7.4.1.1. Only essential personnel should be in the vicinity of pouring operations.

7.4.1.2. Moulds and tundishes should not be damp, nor should there be any means whereby water could enter the melt because of the risk of explosion.

7.4.1.3. The area should be cordoned off prior to the transport of molten metal if there is a possibility of spillage.

#### **7.4.2. Safety specifications for hand-tilted transport ladles**

7.4.2.1. Hand-tilted transport ladles should have an integral locking device to prevent accidental tipping. Large transport ladles (>500 kg) should have a self-restraining anti-tipping device.

7.4.2.2. Casting ladles with rigid ladle bails should have safety devices to prevent the bails from swinging or overturning. The ladle bails should be insulated against radiant heat.

7.4.2.3. Ladles that are transported by forklift truck should have fittings to ensure their stability in forklift devices.

7.4.2.4. Ladles should not be suspended from a crane or other lifting device during filling unless there are specially designed installations to isolate the workers from potential spillage.

7.4.2.5. Ladles should not be overfilled.

#### **Safety and health in the non-ferrous metals industries**

7.4.2.6. Locking devices on casting and transport ladles should be engaged prior to filling to prevent accidental spillage; they should only be released immediately before tipping the ladles.

7.4.2.7. Lubricants that could affect the efficiency of the locking devices and self-restraining drives should not be used.

7.4.2.8. Ladles and other equipment used on molten metal should be dry and, ideally, preheated before use.

7.4.2.9. Stopper operating mechanisms on bottom-pouring ladles should be secured prior to transport to ensure they do not accidentally operate while in motion.

#### **7.4.3. Safety inspection of ladles**

7.4.3.1. A competent person should regularly inspect ladle buckets and their supporting, locking and tipping mechanisms.

7.4.3.2. Before each filling, the pouring, transport and slag ladles and their related appliances should be visually inspected.

7.4.3.3. Test results, including remedies for cracks and other defects, should be recorded.

7.4.3.4. Corrective repair measures that are recommended should be implemented within a specified time.

7.4.3.5. There should be a system for checking and ensuring compliance.

#### **7.4.4. Personal protective equipment**

7.4.4.1. Helmets, gloves, aprons and boots should be provided and used. Where appropriate, molten metal resistant clothing should be provided and used.

#### **Handling molten metal, dross or slag**

##### **7.4.5. Health surveillance and first aid**

7.4.5.1. Injuries caused by molten metal, dross or slag or exposure to alkaline dust should receive immediate medical attention.

## 8. Process and waste gases

8.1. Gases are added during specific processes and are generated as waste by the action of heat on chemicals used in various non-ferrous metals production processes. Besides metal fume, which is described in section 6.1, gases are associated with a variety of processes, including:

- (i) *Moulding*. Resin-bonded sand is coated with phenol- or urea-formaldehyde resin and heated until the mould has set. In hot-box moulding, the resin-sand mix is forced over a heated pattern to produce the mould. In cold-box moulding (“no-bake” moulding), curing takes place at room temperature. Gas catalysts (e.g. carbon dioxide, sulphur dioxide) are sometimes used to facilitate curing. Carbon dioxide causes hyperpnoea at concentrations of 3 per cent and above. At a concentration exceeding 10 per cent, rapid loss of consciousness occurs which can be reversed if the worker is quickly removed from the source and allowed to breathe oxygen. When sulphur dioxide is dissolved in water, it produces sulphuric acid which, if inhaled, causes acute irritation of the mucous membranes. In extreme cases this leads to severe pulmonary oedema and death. Exposure to sulphur dioxide can induce asthma in susceptible individuals.
- (ii) *Pattern making*. Mould patterns are produced using wood, reinforced polyester, plastics, foam or wax. The wax material often contains colophony, a respiratory sensitizer, that is given off during the heated aspects of pattern making.
- (iii) *Core making*. Where a central design or opening is required in the moulded item, cores made of refractory

#### Process and waste gases

materials are incorporated into the mould. The refractory materials often consist of artificial mineral fibres, which are skin irritants. Carbon dioxide and sulphur dioxide are often given off from “binders” during the core-making process.

- (iv) *Shell moulding*. Resin-bonded sand is used to produce moulds. These phenol- or formaldehyde-based resins are a hazard if they are inhaled, ingested or come into contact with the skin. The individual characteristics of the chemical binder should be obtained from the supplier, who should advise on precautions for general use, handling and storage.
- (v) *Hot-box moulding*. Workers are at risk from exposure to a number of agents that are hazardous to health, including phenol-formaldehyde, urea-formaldehyde, furfuryl alcohol-urea, formaldehyde, ammonia, hydrogen cyanide, benzene and toluene.
- (vi) *Cold-box or no-bake moulding*. Core box heating is avoided by the use of sand-resin catalyst systems that cure at room temperature, or urethane systems that use a gas catalyst. The potentially hazardous by-products of these catalysts include urea-formaldehyde, furfuryl alcohol-urea, formaldehyde, phosphoric acid, sulphuric acids, phenol-formaldehyde and isocyanate.
- (vii) *Metal melting and casting*. Molten metal is prepared in high-temperature furnaces and then cast into the shape of the preformed mould. Workers are exposed to various fumes and gases depending on the materials being melted.
- (viii) *Fettling and machining*. Exposure to crystalline silica dust is a recognized hazard of fettling and machining.

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8.2. Further specific information and recommendations for different gases and other compounds can be found in Appendix B.



## **9. Specific metals in the non-ferrous metals industries**

### **9.1. General**

9.1.1. The principal metals used in making non-ferrous alloys are aluminium, cadmium, cobalt, copper, lead, magnesium, manganese, nickel, tin and zinc.

9.1.2. The general principles of prevention and protection are described in Chapter 4. As a guide, the main effects of exposure, both acute and chronic, to these metals and specific health surveillance measures are shown. Details regarding toxicology, epidemiology and medical procedures are available in the ILO *Encyclopaedia of occupational health and safety* (Geneva, 4th edition, 1998), and in publications such as those of the American Conference of Governmental Industrial Hygienists (ACGIH) and the Health and Safety Executive (HSE, United Kingdom).

9.1.3. Combinations of metals are present in alloys. Alloys have unique properties dependent on the proportions of the different constituent elements, and on the presence of trace quantities of other substances. Material safety data sheets will contain information on the properties and biological effects.

### **9.2. Aluminium**

9.2.1. Aluminium or aluminium oxide exposure is not associated with any significant acute or long-term health effects apart from irritation of the mucous membranes and the upper respiratory tract from dusts. Exposure to other agents during the primary production process, such as

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fluorides and sulphur dioxide, is linked to respiratory problems. The lung fibrosis that has been reported after inhalation of alumina (termed “Shaver’s disease”) occurred in workers manufacturing abrasives and who probably also had mixed exposure to crystalline silica. Older processes, linked to an increased risk of cancer, also released other known carcinogens such as polynuclear aromatic hydrocarbons (PAHs).

### **9.3. Arsenic**

9.3.1. Arsenic is used in alloys to increase their hardness and heat resistance. Health effects result from inhalation or ingestion. Drinking contaminated water has been documented as a cause of environmental arsenic poisoning. Chronic arsenic poisoning affects primarily the skin (eczema, folliculitis, arsenical keratosis and skin cancer) and the respiratory tract (nasal septum perforation and lung cancer). There is a synergistic action between smoking and arsenic exposure in terms of causing lung cancer.

9.3.2. Health surveillance procedures include pre-employment and periodic health assessments.

### **9.4. Beryllium**

9.4.1. Beryllium and its compounds when absorbed are widely distributed throughout the body. The main targets are the lungs and skin. Skin contact can cause irritant and/or allergic contact dermatitis. Short-term exposure by inhalation may cause acute irritation and inflammation of the respiratory tract. Long-term exposure may result in fibrotic lung disease (berylliosis), enlargement of the hilar

#### **Specific metals**

lymph nodes, and lung cancer. There is evidence of an immunological basis for chronic beryllium disease. The lung effects should be distinguished from sarcoidosis.

9.4.2. Health surveillance includes pre-placement and periodic medical assessment focusing on the skin and lungs. The detection of clinical effects following health surveillance is an indication for full medical evaluation.

#### **9.5. Cadmium**

9.5.1. Cadmium in the workplace is most commonly absorbed by inhalation of fumes. Once absorbed, cadmium is bound to metallothionein in the liver, and transferred to the kidneys where it can accumulate. As it accumulates, it interferes with renal function leading to the presence of low molecular weight proteins (beta-2 microglobulin) in the urine. Acute effects include gastric and respiratory symptoms. The respiratory effects can lead to pneumonitis, pulmonary oedema and death. Long-term (chronic) exposure can lead to lung damage (emphysema) and renal damage. Cadmium is a recognized lung carcinogen. Smoking should therefore be discouraged and no smoking instituted in workplaces where cadmium is encountered.

9.5.2. Health surveillance procedures include lung function tests and blood cadmium levels for acute and short-term exposure, and urine cadmium for chronic exposure. Urinary beta-2 microglobulin is used as an indicator of biological effect.

#### **9.6. Chromium**

9.6.1. Chromium exists in several valency states. Trivalent chromium is an essential trace metal. Certain

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hexavalent chromium compounds such as calcium chromate are associated with an increased risk of lung cancer. Hexavalent chromium compounds also cause perforation of the nasal septum and allergic contact dermatitis. There are a limited number of case reports linking these compounds to cases of occupational asthma. Cessation of smoking and prohibition of smoking in work areas containing exposure to hexavalent chromium compounds and other respiratory carcinogens are necessary in the prevention of lung cancer and respiratory illness.

9.6.2. Health surveillance procedures include pre-placement assessment focusing on past and present history of allergies, and skin and respiratory tract disease. Biological monitoring using urinary chromium levels has been proposed.

#### **9.7. Cobalt**

9.7.1. Cobalt is an essential trace element and a component of vitamin B12 that is essential for haemoglobin synthesis. Exposure to cobalt in the non-ferrous metals industry is primarily through the skin and airways. Cobalt dust can cause dermatitis. Its use in “hard metal” user industry has resulted in lung fibrosis (hard metal disease).

9.7.2. Health surveillance procedures include pre-placement assessment with consideration of previous and existing respiratory and skin disease. Regular follow-up should be instituted for those at increased risk.

## **9.8. Copper**

9.8.1. Copper is an essential trace element and is absorbed by ingestion and inhalation of fumes and dust. Short-term (acute) exposure through the inhalation of copper fume can cause acute poisoning consistent with metal-fume fever. This presents as a flu-like illness characterized by fever, chills, muscle pain and vomiting. The onset of symptoms may be delayed by up to 24 hours. Recovery is not accompanied by any residual health effects. Copper dust acts as an irritant to eyes, skin and mucous membranes. Long-term (chronic) exposure by ingestion can result in nausea, vomiting, anorexia and greenish discoloration of the skin and hair.

9.8.2. Health surveillance procedures include questionnaires, physical examinations and lung function tests as appropriate. Biological monitoring for copper in blood is not recommended.

## **9.9. Lead**

9.9.1. Absorption of lead occurs mainly via the lungs and by ingestion. Short-term (acute) exposure to inorganic lead can lead to vague symptoms such as headache, fatigue, nausea, abdominal cramps and constipation. Long-term (chronic) exposure causes anaemia and peripheral motor neuropathy. Renal damage and encephalopathy have been described mainly in children and young people. Lead may also impair fertility and cause harm to the unborn child.

9.9.2. Health surveillance procedures should be in accordance with the specifications of the competent authority. These may include the regular measurement of blood

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lead levels, red cell zinc protoporphyrin (or free erythrocyte protoporphyrin) or urinary delta aminolaevulinic acid. Stricter regimes of health surveillance for pregnant workers and women of child-bearing age should apply.

#### **9.10. Magnesium**

9.10.1. Magnesium is an essential trace element. In foundry-casting processes, magnesium or high magnesium alloys, fluoride fluxes and sulphur-containing inhibitors that are used in the process produce fumes that irritate the respiratory tract. Inhalation of magnesium fumes can cause metal-fume fever (see section 9.17). Contamination of skin injuries with magnesium results in delayed wound healing.

9.10.2. No specific procedures are indicated for health surveillance.

#### **9.11. Manganese**

9.11.1. Manganese is an essential trace element. The primary route of exposure is by inhalation. Overexposure may result in chronic manganese poisoning (manganism). The lungs and nervous system are the main target organs affected. The neurological features are similar to Parkinsonism.

9.11.2. Health surveillance consists of periodic medical assessment, with special focus on the lungs and nervous system. No specific biological monitoring tests are indicated.

#### **9.12. Mercury**

9.12.1. Mercury is the only metal which is liquid at room temperature. It vapourizes easily and absorption occurs through inhalation of the vapour. Absorption is poor

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following ingestion of the metal. Skin contact with mercury salts causes irritant dermatitis. Systemic absorption of mercury affects the central nervous system and kidneys. Renal effects include the nephrotic syndrome characterized by loss of protein in the urine.

9.12.2. Health surveillance includes assessment of the central nervous system and checking the urine for proteinuria. Determination of blood mercury is indicated following acute exposure, while urinary mercury provides a better indicator of chronic exposure.

#### **9.13. Nickel**

9.13.1. Exposure to nickel and its compounds in the workplace is primarily by inhalation and skin contact. Acute toxicity occurs mainly with exposure to nickel carbonyl gas. This is an intermediary product encountered in certain nickel-refining processes. Poisoning presents with flu-like symptoms which can lead to a delayed pulmonary oedema and can proceed rapidly to death if not treated. In those industries where nickel carbonyl is found, continuous monitoring of exposure, rapid first-aid and medical management should be provided. All those who work in these industries should be fully trained in first aid, rescue techniques and the use of personal protective equipment (PPE). Inhalation of nickel salt aerosols with short-term exposure has caused asthma, with chronic exposure causing irritation of the nasal mucosa and perforation of the nasal septum. Chronic exposure to certain nickel compounds has also been associated with carcinoma of the lungs and nasal sinuses. Nickel dermatitis is common in the general population, especially among women. Nickel-coated materials such as jewellery worn on

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or in the skin are a recognized major cause of allergic contact dermatitis. Sensitized individuals may react to further contact with nickel salts in the workplace.

9.13.2. Prevention is by avoiding skin contact, using skin barrier creams where necessary and washing immediately following skin contamination with nickel salts. For the prevention of lung effects, smoking should be discouraged, and smoking prohibited, especially where nickel dust and fumes are present.

9.13.3. Health surveillance should include consideration of previous and existing allergies, and respiratory tract and skin disorders. Regular medical follow-up should be provided for those at increased risk.

#### **9.14. Platinum**

9.14.1. The toxic effects of platinum are related to certain water-soluble platinum salts, e.g. chloroplatinates. Inhalation of these salts results in allergic effects on the respiratory system presenting as rhinitis and/or asthma. Contact with these compounds can also cause conjunctivitis, urticaria and contact dermatitis. Smoking appears to increase the risk of sensitization.

9.14.2. Health surveillance includes assessment of a past and current history of allergies, and respiratory and skin disorders. Skin prick tests have been used to detect and monitor the development of an allergic response in exposed individuals.

#### **9.15. Selenium**

9.15.1. Selenium occurs in the sediments and sludge produced during copper refining. Elemental selenium is



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probably completely harmless to humans, although its compounds are toxic. Selenium compounds are absorbed through the lungs and intestinal tract, and via damaged skin. Inhalation of selenium oxide causes delayed pulmonary oedema and splashes of selenium oxide into the eye can lead to chemical conjunctivitis if not treated promptly. Skin contact with selenium dust causes an irritant dermatitis, while selenium oxide can cause an allergic contact dermatitis. Selenium oxide and selenium oxychloride can also cause skin burns. Allergy of the eyelids has been documented in workers exposed to selenium dioxide dust. Penetration of selenium dioxide under the free edge of nails results in a painful paronychia.

9.15.2. There are no specific biological monitoring procedures indicated in terms of health surveillance for selenium-exposed individuals.

#### **9.16. Tin**

9.16.1. Tin is a very common element used in alloys. Tin powders are moderately irritating to the eyes and airways. Inhalation of tin dust leads to stannosis. This presents as prominent chest X-ray changes with little effect on lung structure or function.

9.16.2. No specific health surveillance procedures are indicated.

#### **9.17. Zinc**

9.17.1. Zinc oxide is absorbed via the lungs and through the digestive tract. Metallic zinc, which is stable in dry air, is an essential trace element needed for nucleic acid

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synthesis and certain enzyme functions. Short-term (acute) exposure to heated zinc metal dust can lead to metal-fume fever. This presents as flu-like symptoms with sweating, shivering, headache, fever, chills, thirst, muscle aches, nausea, vomiting and tiredness. The onset of symptoms may be delayed by up to 24 hours. Recovery is not accompanied by harmful sequelae.

9.17.2. Health surveillance procedures include regular review of symptoms.

## **10. Recycling non-ferrous metals**

### **10.1. General treatment**

10.1.1. Non-ferrous metals are recycled from factory offcuts (new scrap), from obsolete/salvaged sources (old scrap) and from foundry slag, ashes and dross. The range of processes used to reclaim metals from scrap depends on the donor source and the desired product. Recycling non-ferrous metals involves different processes from those used in the production of primary metal and presents different occupational safety and health hazards and risks. The following special provisions apply.

10.1.2. Bales of raw scrap received for recycling should be opened and physically inspected prior to adding them to the melt. Potential hazards include rainwater, gas cylinders, aerosols, and munitions as well as radioactive-contaminated scrap. Reputable suppliers of scrap should be used to ensure that the specification of raw materials meets these criteria.

10.1.3. Charge materials should be stored under cover wherever possible.

10.1.4. Potential carriers of moisture should be pre-heated to dry them before charging.

10.1.5. Tubes and pipes that are closed at one or both ends should not be charged.

10.1.6. Bins for storing scrap metal should have holes in their base to facilitate drainage.

10.1.7. Corroded material should not be added to induction furnaces.

10.1.8. The risk from radioactive sources is dealt with in section 5.2.4.

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10.1.9. General hazards encountered in metal reclamation include: manual handling of molten metal; dust; fumes; noise; heat; and toxic vapours.

10.1.10. The burning and drying process used to separate industrial waste (e.g. lathes, milling and boring machines) exposes the operator to non-specific particulate matter, including metals, soot and condensed heavy organic compounds.

10.1.11. Workers should be aware of the dangers of heat stress and supervisors should ensure that these workers take frequent rest breaks and replenish fluids (see section 5.2.3).

10.1.12. When chlorine or fluorine is used in scrap conversion, precautions should be taken to deal with the specific hazards associated with reverberatory chlorine and fluorine refining, namely: pulmonary oedema from contact with chlorine or fluorine; pulmonary fibrosis and fluorosis of bones from contact with fluorine; acid burns from contact with hydrogen chloride or hydrogen fluoride; explosions from aluminium chloride and metal fluorides in contact with water.

10.1.13. General protection and prevention should be observed for these processes and specific effective first-aid measures should be available in the event of a serious incident.

## **10.2. Aluminium recycling**

10.2.1. Aluminium is typically salvaged from machinery, automotive and aircraft parts, beverage cans and domestic appliances, or refined from offcuts and turnings from the manufacture of new alloy products. Scrap alu-

#### **Recycling non-ferrous metals**

minium is first manually inspected and sorted from non-aluminium-bearing material.

10.2.2. Mechanically separating aluminium-laden dross from dirt and other non-recoverable material, and then crushing it, requires a combination of screening and magnetic separation. This “dry milling” process generates noise and dust. Local exhaust and general area ventilation that is sufficient to protect the operators should be used. Operators should wear hearing protection and, if necessary, dust masks.

10.2.3. When de-soldering scrap aluminium, workers should wear respiratory protection against the lead and cadmium fumes which are produced.

10.2.4. Workers involved in the burning and drying process to separate aluminium industrial waste from lathes, and so on, should use appropriate personal protective equipment (PPE) against particulate material and be aware of the dangers of heat stress. Supervisors should ensure that these employees take frequent rest breaks and replenish fluids.

10.2.5. Hot dross processing – the extraction of aluminium from hot slag by rotating the mixture in a refractory-lined barrel and tapping the metal out through a hole in the base – produces fumes that should be removed by using both local exhaust and general area ventilation.

10.2.6. The low melting point of aluminium allows it to be separated from scrap, castings and dross with a high iron content. This “sweating” process is generally carried out using open-flame reverberatory furnaces that create noise and heat hazards. Non-specific gases, fumes and particulates are produced in quantities that require the use of local exhaust and general area ventilation.

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10.2.7. When reverberatory furnaces are used to convert scrap and sweated aluminium into alloys, solvent fluxes and alloying agents are added according to the product specification. The magnesium content of the molten charge is reduced by injecting chlorine or fluorine gas into the melt.

10.2.8. The risk of exposure to these gases or to their compounds should be countered by using the following precautions:

- (i) workers should use both respiratory and hearing protection;
- (ii) the noise source should be isolated from the rest of the factory;
- (iii) both local exhaust and general area ventilation should be in place; and
- (iv) supervisors should be alert to the dangers of heat stress and ensure that workers take regular breaks and replace fluids (see also section 5.2.3).

#### **10.3. Copper recycling**

10.3.1. Hazards from noise and moving machinery are associated with the stripping of insulation from copper wire by shredding the wire and sorting the material by mechanical or pneumatic means. The noise source should be isolated as far as possible, hearing protection should be worn by operators and moving machinery should be guarded in accordance with regulations.

10.3.2. Copper slag, dross, ashes and dust may be ground and/or shredded, then separated by gravity in an aqueous medium. This process exposes the operators to

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noise, non-specific dusts and metal particulates from slag and dross. Operators should wear adequate ear protection and dust masks.

10.3.3. Volatile organic impurities that coat scrap copper can be removed by burning in closed systems. This creates non-specific particulate matter, principally metals, soot and heavy organic compounds. Hazardous gases and vapours, including oxides of nitrogen, sulphur dioxide, carbon monoxide and aldehydes, are also generated.

10.3.4. Low vapour melting components can be removed from scrap by heating them to a temperature just above the melting point of the metals which are to be “sweated” out.

10.3.5. Sweating produces metal fumes, particulates and non-specific gases and vapours. In view of the risk of exposure to possible carcinogens, respiratory sensitizers and other vapours, respiratory protective equipment and PPE should be used if threshold limit values are exceeded.

10.3.6. The production and treatment of “blister” copper during smelting expose the operator to high noise levels and to a range of airborne particulates. Local exhaust ventilation, respirators and PPE, including goggles, should be used.

10.3.7. Copper dust will irritate mucous membranes and respiratory passages. Chronic exposure to metallic copper and copper salts causes liver damage and associated anaemia, anorexia and vomiting. Sufficient people trained in specific, effective first-aid skills should be present or available at all times when copper is being recovered from scrap.

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### **10.4. Lead recycling**

10.4.1. Material that is procured for the reclamation of its lead content often requires processing prior to melting. The nature of lead dust is such that it can permeate the whole facility; it is easily agitated by on-site traffic and readily adheres to skin and clothing.

10.4.2. Automotive batteries are a common and high-yield source of reclaimed lead. Obtaining their lead involves shearing off the top of the battery and separating the components.

10.4.3. Secondary lead-refining operations rely largely on the manual addition of alloying materials to the container of molten metal to produce the required product. Dross is subsequently swept to the rim of the container and removed with a shovel. The principal hazards are from lead particulates, alloying metals, fluxing agents and noise.

10.4.4. These processes generate varying amounts of acid mists, lead dust and other airborne contaminants. Besides general protection and prevention measures, the following specific ones should be implemented:

- (i) work areas should be washed and kept damp with water to minimize dust, and a positive pressure filtered air system should be used where appropriate; and
- (ii) conveyor systems that are used to transport furnace feed materials should be equipped with self-cleaning tail pulleys or belt wipes.

### **10.5. Zinc recycling**

10.5.1. Zinc is reclaimed from “new” scrap from die-casting and galvanizing operations and “old” scrap from a



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variety of sources, notably die castings. A number of separation processes are used, including sweating, crushing, precipitation, alloy formation and distillation. Where possible, the hazards should be eliminated using shields and ventilation. All process operators should be trained and should wear appropriate PPE.

10.5.2. Health surveillance may be required as outlined in sections 4.5 and 4.6.

#### **10.6. Nickel recycling**

10.6.1. Nickel can be reclaimed from nickel, copper and aluminium vapour-based alloys, which can be either salvaged from sources such as machinery and aircraft parts, or refined from offcuts and turnings from the manufacture of new alloy products.

10.6.2. After being manually inspected and sorted from non-nickel-bearing material, scrap nickel should be degreased. Trichlorethylene, a chemical that is commonly used for this purpose, is hepato-toxic.

10.6.3. Scrap nickel is generally smelted in an electric arc furnace. Supplementary refining of molten nickel involves adding the melt to primary nickel and cold scrap in a reactor. Manganese or other suitable alloys are added to produce the desired composition. Molten nickel is then poured from the furnace or reactor into ingot moulds.

10.6.4. These processes expose the worker to nickel dust, general dust, metal fumes, airborne solvents, radiant heat, radiation sources such as depleted uranium, and noise.

10.6.5. Protection and prevention should include health surveillance for respiratory and sensitization effects,

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excessive solvent exposure and radiation exposure as appropriate.

#### **10.7. Cadmium recycling**

10.7.1. Cadmium can be recovered from several sources, including motor vehicles, household appliances and electrical components. “New” scrap largely originates from cadmium-contaminated by-products from other industries. Scrap should be pre-treated by a degreasing process. When it is melted and the pure metal condensed in a retort, operators might be exposed to the by-products of oil and gas combustion, cadmium fumes, solvents, noise and dust, and to the hazards of manual handling. General measures of protection and prevention, as well as health surveillance and biological monitoring as outlined in Chapter 4, should be undertaken.

#### **10.8. Magnesium recycling**

10.8.1. “Old” magnesium scrap is generally obtained from aircraft and automobile parts, and from sludge from primary magnesium smelters. “New” scrap is sourced from offcuts and rejects from sheet mills. Magnesium is highly flammable and must be stored and handled appropriately, with work areas washed and kept moist to minimize the spread of flammable dust. Operators should be aware of the flammable hazards of magnesium dust, and be properly trained and equipped to handle molten magnesium.

## **Appendix A**

### **Occupational exposure limits for hazardous substances, electric and magnetic fields, optical radiation, heat, noise and vibration**

#### **1. Purpose**

1.1. This appendix gives a general introduction to exposure limits for the use of employers and others, and indicates where more information can be obtained. Although some illustrative values are quoted, it is not the purpose of this appendix 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.

1.2. Certain standard-setting bodies rely on technical expertise only. They do not accurately reflect the views of the social partners, e.g. trade unions. This should be taken into account when referring to the standards mentioned in this appendix.

#### **2. General**

2.1. An exposure limit (EL) is a level of exposure 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”, and so on. 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

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authorities have promulgated ELs that 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 intended as guidelines or recommendations in the control of potential workplace health hazards.

2.2. Administrative control levels are provided by the competent authority in Japan. These levels are not limits for individual exposure; they constitute an index to determine the control category (level of cleanliness), and to assess the adequacy of control measures in the working environment. The control category is based on the results of working environment measurements in the work area.

2.3. An important example of the caution to be applied in using ELs is provided in the introduction to the annual publication *Threshold limit values for chemical substances and physical agents and biological exposure indices* of the American Conference of Governmental Industrial Hygienists (ACGIH): threshold limit values (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 that 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.

2.4. 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,

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provided there was a compensating period of low exposure that 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.

2.5. 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, including the competent authority, on these issues.

2.6. 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 that are believed to be safe, and values that are not necessarily safe but that 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 in order 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

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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, 4th edition, 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<sup>3</sup> (milligrams of the chemical in a cubic metre of air). ELs for gases and vapours are usually in ppm (parts of the substance in a million parts of air, by volume), and also in mg/m<sup>3</sup> at a specified temperature and pressure. A smaller number of lists of ELs is available for biological monitoring.

4.2. Many authorities have issued lists of ELs for airborne chemicals, on various assumptions. The International Occupational Safety 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 in-*

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*halation 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* (see paragraph 2.3).

4.5. Prominent national standards are:

- (a) EH 40: *Occupational Exposure Limits* (United Kingdom, Health and Safety Executive (HSE)) (revised annually);
- (b) Technical code of practice TRGS 900 (Technische Regeln für Gefahrstoffe): *Grenzwerte in der Luft am Arbeitsplatz* [*Limit values relating to air in the workplace*] (Germany) (revised annually).
- (c) Code of Federal Regulations, 1910. Subpart Z: *Hazardous and toxic substances* (United States Department of Labor, Occupational Safety and Health Administration, 2001).

### 5. Non-ionizing radiation

5.1. The term “non-ionizing” radiation is given to those regions of the electromagnetic spectrum where the energies of the emitted photons are insufficient, under normal conditions, to produce ionization in the atoms of absorbing molecules. They are usually referred to as ultraviolet, visible and infrared radiation.

5.2. There are as yet no internationally accepted sets of limits for electric and magnetic fields corresponding to the recommendations on ionizing radiation issued by the International Commission on Radiological Protection (ICRP), 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 the physical or physiological effects of the radiation, and some in terms of the strengths of the fields. The relations between the units and quantities are complicated, and different

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quantities have been used in recommended ELs. Many of the recommendations depend on the frequency of the radiation. Units for time-varying quantities usually refer to the root-mean-square (rms) values.

5.3. Guidelines and recommendations can be found in the practical guide on *Protection of workers from power frequency electric and magnetic fields*, Occupational Safety and Health Series, No. 69 (Geneva, ILO, 1994); and in *Human exposure to electromagnetic fields*, ENV 50166-1 (low frequencies) and ENV 50166-2 (high frequencies) (Brussels, European Committee for Electrotechnical Standardization, 1995).

### **6. Ionizing radiation**

6.1. Ionizing radiation is produced when atoms break up. The energy released in this process takes a number of forms that have typical wavelength and frequency, energy and penetrating power.

6.2. Alpha, beta and gamma radiation have sufficient energy to alter other atoms and are termed “ionizing radiation”.

6.3. Alpha and beta radiation are composed of relatively large particles with very little penetration. While alpha particles travel only a few centimetres in air and are incapable of penetrating the skin, beta particles have a range of more than 1 metre in air and up to 1 centimetre or so in tissue. Alpha and beta radiation cause biological damage, mainly from inhaled or ingested sources of material.

6.4. Gamma radiation or X-rays can pass through tissues from an external source, including plant walls and equipment.

### **7. Heat**

7.1. A series of international standards, including those of the ISO, is helpful in the 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.



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7.2. In hot environments, ISO 7243:1989 *Hot environments – Estimation of the heat stress on working man, based on the WBGT-index (wet bulb globe temperature)* gives a rapid method based on the 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.

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

7.4. The ACGIH publication *Threshold limit values for chemical substances and physical agents and biological exposure indices* (see paragraph 2.3 of this appendix) gives details of work/rest regimes and is revised annually.

## 8. Noise

8.1. 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. Users should apply standards that are adopted or

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recognized by the competent authority. These include a series of ISO standards on acoustics (1999:1990; 4871:1996; 9612:1997; 7196:1995; 11690:1996).

#### **9. Vibration**

9.1. 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.

9.2. 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).

9.3. 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 provides guidelines for measurement).

## **Appendix B**

### **Additional chemicals used in the non-ferrous metals industries**

#### **Ammonia**

Short-term (acute) inhalation causes severe irritation of the respiratory tract. Skin contact results in burns, blistering and, possibly, permanent scarring of the skin. Eye contact causes irritation and, possibly, corrosive injury.

#### **Benzene**

Short-term (acute) inhalation causes depression of the central nervous system, marked by drowsiness, dizziness, headache, nausea, loss of coordination, confusion and unconsciousness. Long-term exposure to benzene reduces the number of red and white blood cells and damages bone marrow. Benzene is carcinogenic.

#### **Carbon monoxide**

Inhalation of carbon monoxide causes symptoms including headache, weakness, dizziness, nausea, fainting, increased heart-beat, irregular heartbeat, loss of consciousness and death.

#### **Chlorine**

If inhaled, chlorine causes severe breathing difficulties and pulmonary oedema. It can aggravate respiratory diseases, such as bronchitis and asthma.

#### **Cyclohexane**

Short-term (acute) inhalation can cause headache, nausea, dizziness, drowsiness and confusion. In very high concentrations,

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unconsciousness and death can result. Ingestion of extremely large doses may cause nausea, vomiting, diarrhoea and headache.

#### **Formaldehyde**

Short-term (acute) exposure through the inhalation of vapour can cause severe irritation of the nose, throat and windpipe. Formaldehyde solutions can cause primary irritation resulting in tingling, drying and reddening of skin. Eye contact results in irritation and tingling of the eye; concentrated solutions can cause severe eye injury.

Ingestion of formaldehyde causes irritation, severe pain in the mouth, throat, oesophagus and intestinal tract. Later symptoms can include dizziness, depression and coma.

Long-term (chronic) exposure through inhalation causes irritation of mucous membranes and the upper respiratory tract. Long-term skin contact causes skin allergy.

#### **Hydrogen cyanide**

Short-term (acute) inhalation or ingestion causes weakness, headache, giddiness, dizziness, confusion, anxiety, nausea and vomiting. High concentrations can cause death within minutes or hours. There may be a bitter, pungent, burning taste in the mouth.

Long-term (chronic) exposure causes a persistent runny nose, weakness, dizziness, giddiness, headache, nausea, abdominal pain, vomiting, throat irritation, changes in taste and smell, muscle cramps, weight loss, flushing of the face and enlargement of the thyroid gland.

#### **Phenol**

Short-term (acute) contact with skin, eye or mucous membranes leads to numbness or slight tingling, then burns, blisters, permanent skin damage and gangrene, damage to the mouth, throat and stomach, internal bleeding, vomiting, diarrhoea and

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decreased blood pressure. Shock, collapse, coma and death may result.

### **Sulphuric acid**

Short-term (acute) exposure through inhalation can cause severe irritation or corrosive damage. Symptoms can include severe lung damage, coughing and shortness of breath. Sulphuric acid is corrosive and contact with the skin causes severe irritation and burns that may result in permanent scarring. Eye contact results in severe irritation, redness, swelling, pain and, possibly, permanent damage, including blindness. Ingestion causes burns to the mouth, throat, oesophagus and stomach. Symptoms include difficulty in swallowing, intense thirst, nausea, vomiting, diarrhoea and, in severe cases, collapse and death.

Long-term (chronic) exposure can cause red, itchy, dry skin and dental erosion.

### **Toluene**

Short-term (acute) exposure through inhalation or ingestion causes central nervous system depression. Irritation of the nose, throat and respiratory tract are minor symptoms.

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