

## **Safety and health in underground coalmines**



ILO code of practice

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# **Safety and health in underground coalmines**

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**International Labour Office** Geneva

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## **Preface**

This new ILO code of practice provides governments, employers and workers with globally applicable guidelines – based on international labour instruments and established industry best practice – for addressing specific occupational hazards in underground coalmines. The code is not a legally binding instrument, nor is it intended to replace national laws or regulations or to affect the fundamental principles and rights of workers provided by ILO instruments; it is a set of practical guidelines.

The code was adopted unanimously by a Meeting of Experts on Safety and Health in Coal Mines, held in Geneva from 8 to 13 May 2006. It replaces an earlier code of practice that was adopted in 1985.

The good spirit of cooperation among all participants paved the way for developing consensus on a new, comprehensive and practical code that will be useful for all who work in all aspects of underground coalmining.

The Governing Body of the ILO approved the publication of the code at its 297th Session (November 2006).

Feedback on the code and its implementation, as well as requests for further information or assistance, is welcome and may be addressed to:

The Director  
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The meeting was composed of 23 Government, Employer and Worker experts.

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## Glossary

In this code of practice, the following terms have the meanings hereby assigned to them.

*Active monitoring:* The ongoing activities which check that hazard identification, risk assessment and the appropriate preventive and protective measures, as well as the arrangements to implement the occupational safety and health (OSH) management system, conform to defined criteria.

*AMS:* Atmospheric monitoring system.

*Asphyxiant:* A substance that causes injury by decreasing the amount of oxygen available to the body. Asphyxiants may act by displacing air from an enclosed space, or by interfering with the body's ability to absorb and transport oxygen.

*Audit:* A systematic, independent and documented process for obtaining evidence and evaluating it objectively to determine the extent to which defined criteria are fulfilled. Audits should be conducted by competent persons internal or external to the facility who are independent of the activity being audited.

*Competent authority:* A ministry, government department or other public authority with the power to issue regulations, orders or other instructions having the force of law. Under national laws or regulations, competent authorities may be appointed with responsibilities for specific activities, such as for the implementation of national policy and procedures for coalmine safety and health.

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

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*Contractor:* A person or an enterprise providing services to an employer at the facility in accordance with national laws and regulations, or with agreed specifications, terms and conditions. For the purpose of this code of practice, contractors include principal contractors, subcontractors and labour-supply agents.

*Dangerous occurrence:* Readily identifiable event, as defined under national laws and regulations, with potential to cause injury or disease to people at work or the general public.

*Employer:* Any physical or legal person who employs one or more workers in a mine and, as the context requires, the operator, principal contractor, contractor or subcontractor.

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

*Engulfment:* The condition of being swallowed up or overwhelmed by loose material, for example in the cave-in of an unshored trench. Engulfment usually causes injury by asphyxiation or crushing.

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

*Goaf and gob:* The parts of a mine from which the coal has already been removed, with the intention of allowing the roof to collapse.

*Hazard:* The inherent potential to cause illness or injury.

*Hazard identification:* The systematic process of identifying hazards in the workplace. See Annex III, section 11, for a description of the process that should be considered.

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

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

*Inbye:* Towards the coalface.

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

*Labour inspectorate:* The body established according to national laws and regulations to secure the enforcement of the legal provisions relating to the conditions of work and the protection of workers while engaged in their work.

*Labour supply agent:* Supplier or provider of workers.

*Manager:* A competent and appointed person legally responsible for the management and technical direction of the mine whether he/she is the employer or a person appointed by the employer.

*MSDS:* Material safety data sheet.

*Occupational accident:* An occurrence arising out of or in the course of work which results in a fatal or non-fatal occupational injury.

*Occupational disease:* Disease contracted as a result of an exposure to risk factors arising from work activity.

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

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

*Occupational injury:* Death or any personal injury resulting from an occupational accident.

*OSH:* Occupational safety and health.

*OSH management system:* A set of interrelated or interacting elements to establish OSH policy and objectives, and to achieve those objectives.

*Outbye:* Away from the coalface.

*PPE:* Personal protective equipment.

*Reactive monitoring:* The process of identifying gaps or failures in prevention control measures, including OSH management systems, that arise from accidents, injuries, diseases, ill health and incidents, and correcting such deficiencies.

*Recording:* A procedure, specified in national laws and regulations, which establishes the means by which the employer ensures that information is maintained on:

- (a) occupational accidents and diseases;
- (b) dangerous occurrences and incidents.

*Reporting:* A procedure, specified by the employer, in accordance with national laws and regulations and with the practice of the enterprise, for the submission by workers to their immediate supervisor, the competent person, or any other specified person or body, of information on:

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

*Respirable dust:* Airborne material which is capable of penetrating to the gas exchange region of the lungs.

*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 and control:* A process used to determine the level of risk of injury or illness associated with each identified hazard, for the purpose of control. All risks should be assessed and have control priorities assigned, based on the established level of risk. See Annex I for a description of the process that should be considered.

*Safety and health committee:* A committee with representation of workers' safety and health representatives and employers' representatives, established and functioning at facility level according to national laws, regulations and practice.

*Second mining:* Intentional retreat mining where pillars have been wholly or partially removed, regardless of the amount of recovery obtained.

*Small mines:* For the purposes of this code, a small mine is a mine which employs few people with low levels of output and investment of capital, or, as defined by the competent authority.

*Social security:* The protection that a society provides to individuals and households to ensure access to health care and to guarantee income security, particularly in cases of old age, unemployment, sickness, invalidity, work injury, maternity or loss of a breadwinner.

## **Safety and health in underground coalmines**

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

*Surveillance of the working environment:* A generic term which includes 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 risks to the health of workers, collective and personal protective equipment (PPE), exposure of workers to hazardous agents, and control systems designed to eliminate and 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.

*Welfare:* Statutory procedure or social effort designed to promote the basic physical and material well-being of people in need.

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

*Workers' health surveillance:* A generic term which covers 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 and their representatives:* Where reference is made in this code of practice to workers and their representatives, the intention is that, where representatives exist, they should be consulted as the means of achieving appropriate worker participation. In some

instances, it may be appropriate to involve all workers and all representatives.

*Workers' representative:* In accordance with the Workers' Representatives Convention, 1971 (No. 135), any person who is recognized as such by national law or practice, whether they are:

- (a) trade union representatives, namely, representatives designated or elected by trade unions or by members of such unions; or
- (b) elected representatives, namely, representatives who are freely elected by the workers of the enterprise in accordance with provisions of national laws or regulations or of collective agreements and whose functions do not include activities which are recognized as the exclusive prerogative of trade unions in the country concerned.

*Workplace:* Area where workers need to be, or to go to, on the instruction of an employer to carry out their work. A workplace need not be a fixed location.

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



## Introduction

In accordance with the decision taken by the Governing Body of the ILO at its 292nd Session in March 2005, a Meeting of Experts on Safety and Health in Coal Mines was convened in Geneva from 8 to 13 May 2006 to draw up and adopt a revised code of practice on safety and health in coalmines. The Meeting was composed of eight experts appointed following consultations with Governments, eight experts appointed following consultations with the Employers' group and eight experts appointed following consultations with the Workers' group of the Governing Body.

The original code of practice on safety and health in coalmines was adopted by the Governing Body in 1986. This new code, which reflects the many changes in the industry, its workforce, the roles of the competent authorities, employers, workers and their organizations, and the development of new ILO instruments on occupational safety and health, focuses on the production of coal from underground mines. Surface mining is covered by the code of practice *Safety and health in opencast mines* (1991).

This code of practice is based on principles established in international instruments relevant to the protection of workers' safety and health. The first two chapters deal with the objectives and application of the code. The next two chapters address, within a national framework, the responsibilities, duties and rights of the competent authority, the labour inspectorate, employers, workers and their organizations, suppliers, manufacturers, designers, and contractors, and occupational safety and health (OSH) management systems and services and OSH reporting.

Part II of the code provides a methodology for identifying hazards and addressing risks.

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Part III of the code addresses various hazards that commonly exist in the production of coal from underground mines – from dust, explosions, fires and water inrushes to electrical hazards, machinery and hazards on the surface. Each section describes hazards, assesses risk and provides guidance on eliminating or controlling risk. It also covers the proper design and maintenance of coalmines and transport, competence and training, personal protective equipment (PPE), emergency preparedness, and special protection and hygiene issues.

Where appropriate, the code draws on relevant parts of existing ILO instruments, including: *Safety and health in coal mines* (Geneva, 1986), *Management of alcohol- and drug-related issues in the workplace* (Geneva, 1996); *Technical and ethical guidelines for workers' health surveillance* (Geneva, 1998); *Guidelines on occupational safety and health management systems* (Geneva, 2001); *Ambient factors in the workplace* (Geneva, 2001); *HIV/AIDS and the world of work* (Geneva, 2001). The annexes include information drawn from relevant ILO instruments on workers' health surveillance, surveillance of the working environment and on establishing an OSH management system. As these instruments are updated, the references to them in electronic versions of this code will be adjusted accordingly. There is also information on exposure limits.

The practical recommendations of ILO codes of practice are intended for the use of 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. construction, 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 objective of providing guidance, in accordance with the provisions of national laws and regulations, 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 national or enterprise levels. They are addressed in particular to governmental and public authorities, employers and workers and their organizations, as well as to 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 guidance it contains, the scale of operation involved and technical possibilities. In this regard, the needs of developing countries are also taken into consideration.



# 1. General provisions

## 1.1. Background

1.1.1. Historically, underground coalmining has been one of the highest risk activities as far as the safety and health of the workforce are concerned. Significant, sustained improvements in coalmining occupational safety and health have been achieved as a result of new technologies, capital investment, continuous training and changes in attitudes to safety and health among the competent authorities, employers, workers and their representatives. Nonetheless, if a safety net, which includes a number of critical checks and balances, is not in place to assess and control the hazards, accidents, ill health and diseases can and do occur.

1.1.2. The underground coalmining industry has never been more diverse and dynamic. Industrialization was, and continues to be, fuelled by coal. Internationally, coal is the most widely used energy source in electricity generation and an essential input to most steel production; consequently, it is of great importance for many countries' economies. The importance of coal is witnessed by unprecedented growth rates in its consumption and production, in particular in Asia. This positive trend is further strengthened by recent developments in the coal industry. A growing trend towards technologies such as coal liquification or gasification and clean coal technologies will contribute to further and sustained demand for coal.

1.1.3. In some countries the legislative focus has adopted a hazard identification, risk assessment and control approach, in others a prescriptive approach prevails, and elsewhere national legislation on safety and health is lacking. Underground coalmining is undertaken by both large and small enterprises. While some enterprises

## **Safety and health in underground coalmines**

have at their disposal significant internal technical resources, others do not have access to such resources.

1.1.4. The practical recommendations of this code of practice are intended for the use of all those who have rights, responsibilities and duties regarding safety and health in underground coalmining.

1.1.5. The code addresses most of the currently identified hazards and risks associated with underground coalmining; however, changes in the industry or at specific operations may alter the risk profile of an operation. For this reason, the code cannot be assumed to address every hazard or risk.

1.1.6. The purpose of this code is to provide practical guidance in support of the provisions of the Safety and Health in Mines Convention, 1995 (No. 176), and its accompanying Recommendation, 1995 (No. 183). The code is not a legally binding instrument and is not intended to replace national laws, regulations and accepted standards.

1.1.7. While the code contains detailed provisions, its use should not inhibit the development of new technologies, better practice or the adoption of alternative measures that provide effective protection to all persons involved in underground coalmining.

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

## **1.2. Objectives**

1.2.1. This code of practice should contribute:

## General provisions

- (a) to protecting workers in underground coalmines from workplace hazards and to preventing or reducing work-related injuries and diseases, ill health and incidents;
- (b) to assisting and facilitating the improved management of OSH issues at the workplace;
- (c) to promoting effective consultation and cooperation between governments, employers, workers and their organizations in the improvement of OSH in the production of coal from underground mines.

1.2.2. This code of practice should assist in:

- (a) establishing a coherent national policy and principles on the occupational safety and health and welfare of workers in underground coalmines and on the protection of the general working environment;
- (b) establishing the respective duties and responsibilities for occupational safety and health of the authorities, employers, workers and others involved and making arrangements for a structured cooperation between them;
- (c) improving knowledge and competence;
- (d) promoting the implementation and integration of consistent OSH management systems with a view to improving working conditions.

1.2.3. This code of practice 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:

- (a) the setting up of legal, administrative and effective frameworks for the prevention and reduction of hazards and risks;
- (b) the aims of any mechanisms for identifying, eliminating, minimizing and controlling hazards;

## **Safety and health in underground coalmines**

- (c) the assessment of risks and hazards to the safety and health of workers and the measures that need to be taken;
- (d) the surveillance of the working environment and of workers' health;
- (e) emergency procedures and first aid;
- (f) the provision of information and training to workers;
- (g) the establishment of a system to record, report and monitor occupational accidents and diseases, and dangerous occurrences.

### **1.3. Application and purpose**

1.3.1. This code of practice, which is applicable to all operations in underground coalmining, should provide guidance, in accordance with the provisions of national laws and regulations, to:

- (a) all those government authorities, workers' and employers' organizations and industry associations, whether legislative or advisory, whose activities influence the safety, health and welfare of workers in underground coalmines;
- (b) all those individuals at the level of the coalmine, i.e. employers, persons in control of premises, and workers and contractors, as appropriate to their duties and responsibilities for safety and health.

1.3.2. A number of OSH measures implemented to protect workers' health and safety in underground coalmining may have an effect, directly or indirectly, on the general environment. This relationship should be taken into account by both the competent authorities and employers in designing and implementing their respective policies and programmes.

1.3.3. The provisions of this code are not intended to replace applicable laws, regulations or accepted standards. More stringent applicable requirements should have priority over the provisions of

this code. In the absence of national laws and regulations on a particular OSH issue, guidance should be drawn from this code of practice, as well as from other relevant nationally and internationally recognized instruments.

1.3.4. 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.

### 1.4. Reference to other ILO instruments

1.4.1. In the establishment, implementation and review of policies and programmes on OSH in underground coalmines under this code of practice, competent authorities and employers' and workers' organizations should take account of the provisions of other relevant ILO instruments, including Conventions, Recommendations, codes of practice and guidelines. A list of these is contained in the bibliography at the end of this code.

## **2. Industry characteristics**

### **2.1. Underground coalmining**

2.1.1. Coal is produced from underground mines in about 50 countries. Underground coalmines range from modern mines using the latest remote-controlled equipment operated by a small, highly skilled workforce benefiting from continuous monitoring of all aspects of workplace conditions, to mines that are dug by hand and where the coal is extracted and transported by hand in conditions that are inherently unsafe and unhealthy.

2.1.2. Coal extraction, transport and processing can involve an array of health and safety hazards that can result in injury, illness and death, if not properly controlled. In underground mines the shape and size of the workplace, with no natural light or natural ventilation, changes on a continual basis.

### **2.2. Occupational hazards**

2.2.1. Operations in underground coalmines may expose workers to a wide range of hazards or workplace activities or conditions that could cause incidents, injury, death, ill health or diseases. These are discussed in the following chapters.

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## **PART I. NATIONAL FRAMEWORK**

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### **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. Measures for cooperation should be taken relating to the identification of hazards and the elimination or control of risks to safety and health from the production of coal from underground mines. These measures should include the following:

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

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

##### **3.2.1. General provisions**

3.2.1.1. 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:

## **Safety and health in underground coalmines**

- (a) devise and maintain a national policy on OSH; and
- (b) consider making new, or updating existing, statutory provisions for the identification of hazards and the elimination or control of risks in the production of coal from underground mines.

3.2.1.2. Statutory provisions should include regulations, codes of practice, exposure limits and procedures for consultation with and dissemination of information to employers, workers and their representatives.

3.2.1.3. The competent authority should establish, in accordance with the provisions of relevant ILO Conventions and taking into account the need to harmonize such systems internationally:

- (a) systems, including criteria, for classifying substances that may be hazardous to health;
- (b) systems and criteria for assessing the relevance of the information required to determine whether a substance is hazardous;
- (c) requirements for marking and labelling substances. Substances for use in underground coalmining should be marked and labelled according to these requirements;
- (d) criteria for the information contained in the substance safety data sheets received by employers; and
- (e) systems and criteria for identifying safety hazards and appropriate risk control measures relating to machinery, equipment, processes and operations used in the production of coal from underground mines.

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.

3.2.1.4. The competent authority should secure the enforcement of national laws and regulations concerning the policy men-

tioned 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.

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

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

3.2.1.6. 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.

### 3.2.2. Labour inspectorates

3.2.2.1. Labour inspectorates should, in a manner prescribed by national laws and regulations:

- (a) enforce all relevant laws and regulations at underground coalmines;
- (b) periodically carry out inspections in the presence of the employers' and workers' representatives, and monitor compliance with all relevant laws and regulations at underground coalmines;

## **Safety and health in underground coalmines**

- (c) assist employers, workers and their representatives with respect to their occupational safety and health responsibilities, duties and rights;
- (d) monitor the safety and health requirements and performance of comparable national or international coalmining facilities to provide feedback for further development and improvement of safety measures; and
- (e) participate, in cooperation with the recognized organizations of employers and workers, in formulating and updating safety rules and measures to be adopted at national and enterprise levels.

3.2.2.2. Labour inspectors should, in a manner prescribed by national laws and regulations:

- (a) be competent to deal with the safety and health issues associated with underground coalmining and be able to provide support and advice;
- (b) have the authority to investigate fatal and serious accidents, dangerous occurrences and mine disasters;
- (c) notify the employer, the workers concerned and their representatives, as well as safety and health committees, of the findings of inspections and the required remedial action;
- (d) have the authority to remove workers from situations involving an imminent and serious danger to life or health;
- (e) periodically determine whether an existing OSH management system or OSH elements are in place, and are adequate and effective; and
- (f) have authority to suspend or restrict mining activities on safety and health grounds, until the condition giving rise to the suspension or restriction has been corrected.

3.2.2.3. The authority, rights, procedures and responsibilities of labour inspectors should be communicated to all affected parties.

### 3.3. Employers' responsibilities and rights

3.3.1. In taking preventive and protective measures the employer should assess the risk and deal with it in the following order of priority:

- (a) eliminate the risk;
- (b) control the risk at source;
- (c) minimize the risk by means that include the design of safe work systems; and
- (d) in so far as the risk remains, provide for the use of personal protective equipment,

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

3.3.2. Employers should take all necessary measures to eliminate or minimize the risks to safety and health in underground coalmines under their control, and in particular:

- (a) ensure that the mine is designed, constructed and provided with electrical, mechanical and other equipment, including a communication system, to provide conditions for safe operation and a healthy working environment;
- (b) ensure that the mine is commissioned, operated, maintained and decommissioned in such a way that workers can perform the work assigned to them without endangering their safety and health or that of other persons;
- (c) take steps to maintain the stability of the ground in areas to which persons have access in the context of their work;

## **Safety and health in underground coalmines**

- (d) where practicable, provide, from every underground workplace, two exits, each of which is connected to separate means of egress to the surface;
- (e) ensure the monitoring, assessment and regular inspection of the working environment to identify the various hazards to which the workers may be exposed and to assess their level of exposure;
- (f) ensure adequate ventilation for all underground workings to which access is permitted;
- (g) in respect of zones susceptible to particular hazards, draw up and implement an operating plan and procedures to ensure a safe system of work and the protection of workers;
- (h) take measures and precautions appropriate to the nature of a mine operation to prevent, detect and combat the start and spread of fires and explosions;
- (i) ensure that, when there is serious danger to the safety and health of workers, operations are stopped and workers are evacuated to a safe location; and
- (j) ensure that, when managers or supervisory officials observe non-compliance with safety and health regulations or codes of practice by any person, they take corrective action immediately. If such action is unsuccessful, the problem should be referred to a higher level of management immediately.

3.3.3. The employer should prepare an emergency response plan, specific to each mine, for reasonably foreseeable industrial and natural disasters.

3.3.4. Where workers are exposed to physical, chemical or biological hazards the employer should:

## General duties

- (a) inform the workers, in a comprehensible manner, of the hazards associated with their work, the health risks involved and relevant preventive and protective measures;
- (b) take appropriate measures to eliminate or minimize the risks resulting from exposure to those hazards;
- (c) where adequate protection against risk of accident or injury to health, including exposure to adverse conditions, cannot be ensured by other means, provide and maintain at no cost to the worker suitable protective equipment, clothing as necessary and other facilities defined by national laws or regulations; and
- (d) provide workers who have suffered from an injury or illness at the workplace with first aid, appropriate transportation from the workplace and access to appropriate medical facilities.

3.3.5. The employer should ensure that:

- (a) adequate training and retraining programmes and comprehensible instructions are provided for workers, at no cost to them, on safety and health matters as well as on the work assigned;
- (b) adequate supervision and control are provided on each shift to secure the safe operation of the mine;
- (c) a system is established so that the names of all persons who are underground can be accurately known at any time, as well as their probable location;
- (d) all accidents and dangerous occurrences are investigated and appropriate remedial action is taken; and
- (e) a report, as specified by national laws and regulations, is made to the competent authority on accidents and dangerous occurrences.

3.3.6. On the basis of general principles of occupational health and in accordance with national laws and regulations, the employer should ensure the provision of regular health surveillance of workers exposed to occupational health hazards specific to mining.

## **Safety and health in underground coalmines**

3.3.7. Whenever two or more employers undertake activities at the same mine, the employer in charge of the mine should coordinate the implementation of all measures concerning the safety and health of workers and shall be held primarily responsible for the safety of the operations. This should not relieve individual employers from responsibility for the implementation of all measures concerning the safety and health of their workers.

3.3.8. When an employer is also a national or multinational enterprise with more than one establishment, the employer should take safety and health measures relating to the prevention and control of, and protection against, injuries and risks to safety and health from underground coalmining, applicable to all workers without discrimination.

3.3.9. In accordance with the Tripartite Declaration of Principles concerning Multinational Enterprises and Social Policy (1977, Rev. 2000), in all countries in which they operate, multinational enterprises should make available to the representatives of the workers at the facility and, on request, to the competent authorities and the workers' and employers' organizations in all countries in which they operate, information on the safety and health standards on underground coalmining, relevant to their local operations, which they observe in other countries.

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

3.4.1. Workers should have the following rights:

- (a) to report accidents, dangerous occurrences and hazards to the employer and to the competent authority;
- (b) to request and obtain, where there is cause for concern on safety and health grounds, inspections and investigations to be conducted by the employer and the competent authority;

## General duties

- (c) to know and be informed of workplace hazards that may affect their safety or health;
- (d) to obtain information relevant to their safety or health, held by the employer or the competent authority;
- (e) to remove themselves from any location at the mine when circumstances arise which appear, with reasonable justification, to pose a serious danger to their safety or health; and
- (f) to collectively select safety and health representatives.

3.4.2. The safety and health representatives should have the following rights:

- (a) to represent workers in the exercise of their rights;
- (b) to:
  - (i) participate in inspections and investigations conducted by the employer and by the competent authority at the workplace; and
  - (ii) monitor and investigate safety and health matters;
- (c) to have recourse to advisers and independent experts;
- (d) to consult with the employer in a timely fashion on safety and health matters, including policies and procedures;
- (e) to consult with the competent authority; and
- (f) to receive, relevant to the area for which they have been selected, notice of accidents and dangerous occurrences.

3.4.3. Workers and safety and health representatives should be entitled to exercise their rights without discrimination or retaliation.

3.4.4. Workers should have the duty, in accordance with their training:

- (a) to comply with prescribed safety and health measures;
- (b) to take reasonable care for their own safety and health and for that of other persons who may be affected by their acts or omissions at work, including the proper care and use of protective

## **Safety and health in underground coalmines**

clothing, facilities and equipment placed at their disposal for this purpose;

- (c) to report forthwith to their immediate supervisor any situation which they believe could present a risk to their safety or health or to that of other persons, and which they cannot properly deal with themselves; and
- (d) to cooperate with the employer to permit compliance with the duties and responsibilities placed on the employer.

### **3.5. General responsibilities of suppliers, manufacturers and designers**

3.5.1. Measures should be taken to ensure that those who design, manufacture, import, provide or transfer machinery, equipment or substances for use in underground coalmines:

- (a) ensure that the machinery, equipment or substances do not entail dangers for the safety and health of those using them correctly; and
- (b) make available:
  - (i) information concerning their requirements for the correct installation and use of machinery and equipment and the correct use of substances;
  - (ii) information concerning the hazards of machinery and equipment, and the dangerous properties of hazardous substances and physical agents or products; and
  - (iii) information on how to eliminate or control risks arising from the identified hazards associated with the products.

### **3.6. General responsibilities and rights of contractors**

3.6.1. Contractors should comply with the arrangements established by the underground coalmine on site, which should:

## General duties

- (a) include OSH criteria in procedures for evaluating and selecting contractors;
- (b) establish effective ongoing communication and coordination between appropriate levels of the mine and the contractor prior to commencing work, which should include provisions for identifying hazards and the measures to eliminate and control risks;
- (c) include arrangements for reporting work-related injuries and diseases, ill health and incidents among the contractors' workers while performing work for the mine;
- (d) provide relevant workplace safety and health hazard awareness and training to contractors or their workers prior to commencing work and as work progresses, as necessary;
- (e) regularly monitor OSH performance of contractor activities on site; and
- (f) ensure that on-site OSH procedures and arrangements are followed by the contractor(s).

3.6.2. When using contractors, the commissioning party should ensure that:

- (a) the same safety and training requirements apply to the contractors and their workers as to the workers in the establishment;
- (b) where required, only such contractors are used that have been duly registered or hold licences; and
- (c) contracts specify safety and health requirements as well as sanctions and penalties in case of non-compliance. Contracts should include the right for supervisory officials mandated by the commissioning party to stop work whenever a risk of serious injury is apparent and to suspend operations until the necessary remedies have been put in place.

## **4. Occupational safety and health management systems; reporting, recording and notification of work-related injuries and diseases, ill health and incidents; occupational health services**

### 4.1. Introduction

4.1.1. Numerous other principles contained in existing ILO instruments – too lengthy to reproduce in this text – are relevant to OSH in underground coalmining. These address: occupational safety and health management systems; reporting, recording and notification of work-related injuries and diseases, ill health and incidents; and occupational health services. Other relevant instruments are listed in the Bibliography and summarized in Annexes I, II, III and IV. They may be updated from time to time and users of this code should check for updated versions.

### 4.2. OSH management systems

4.2.1. The process of improving working conditions in underground coalmines should be approached systematically. With a view to achieving acceptable environmentally sound OSH conditions, it is necessary to invest in permanent structures for their continuous review, planning, implementation, evaluation and action. This should be done through the implementation of OSH management systems. The systems should be specific to the facilities and appropriate to their size and the nature of activities. Their design and application at national and facility levels should be guided by the ILO *Guidelines on occupational safety and health management systems, ILO-OSH 2001* (available at <http://www.ilo.org/public/english/protection/safework/cops/english/download/e000013.pdf>).

4.2.2. Typically, an OSH management system should contain the following main elements:

## Occupational safety and health management systems

- (a) OSH policy;
- (b) necessary conditions for the employer organization, i.e. establishment of responsibility and accountability, competence and training, documentation, communication and information;
- (c) worker participation;
- (d) hazard and risk assessment, planning and implementation of OSH activities; and
- (e) evaluation of OSH performance and action for improvement.

### 4.3. Reporting, recording and notification of work-related injuries and diseases, ill health and incidents

4.3.1. It should be the obligation of the employer to notify the competent authority of all serious work-related injuries, diseases, ill health and incidents in a timely manner as specified by the competent authority.

4.3.2. Likewise, in the establishment, review and application of systems for the reporting, recording and notification of work-related injuries and diseases, ill health and incidents (see Glossary for the assigned meanings), the competent authority should take account of the Employment Injury Benefits Convention, 1964 (No. 121), and its Schedule I, as amended in 1980, the ILO Protocol of 2002 to the Occupational Safety and Health Convention, 1981 (No. 155), the List of Occupational Diseases Recommendation, 2002 (No. 194), and the ILO code of practice *Recording and notification of occupational accidents and diseases* (1996).

4.3.3. Reporting, recording, notification and investigation of work-related injuries and diseases, ill health and incidents are essential for reactive monitoring and should be undertaken to:

- (a) provide reliable information about occupational accidents and diseases at facility and national level;

## **Safety and health in underground coalmines**

- (b) identify major safety and health problems arising from underground coalmining activities;
- (c) define priorities of action;
- (d) evolve effective methods for dealing with occupational accidents and diseases; and
- (e) monitor the effectiveness of measures taken to secure satisfactory levels of safety and health.

### **4.4. Occupational health services**

4.4.1. Consistent with the Occupational Health Services Convention, 1985 (No. 161), and Recommendation, 1985 (No. 171), the competent authority should make provision for the establishment of occupational health services:

- (a) by laws or regulations;
- (b) by collective agreements or as otherwise agreed upon by the employers and workers concerned; or
- (c) in any other manner approved by the competent authority after consultation with the representative organizations of employers and workers concerned.

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**PART II. METHODOLOGY FOR IDENTIFYING HAZARDS  
AND ADDRESSING RISKS**

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## **5. Prevention and protection**

### **5.1. Industry-specific safety and health hazards**

5.1.1. The health and safety risks to coalminers include but are not limited to:

- (a) mine explosions;
- (b) mine fires;
- (c) falls of the mine roof, face and sides (ribs);
- (d) disabling and deadly lung diseases caused by the inhalation of respirable coalmine dust;
- (e) noise-induced hearing loss;
- (f) crushing of a miner between machinery or machinery and the coal sides in confined spaces;
- (g) shock, burns and electrocution;
- (h) ignitions of methane which can explode during coal cutting;
- (i) inundations of dangerous gases, water or other free-flowing materials from old mine workings or geological faults;
- (j) outbursts of rock, coal or gases released from the earth under extreme pressure;
- (k) premature or improper detonation of explosives; and
- (l) exposure to harmful chemicals and harmful agents used in mines.

5.1.2. Numerous other hazards in coalmines that can result in injury, illness or death include the following:

- (a) slips, trips and falls;
- (b) handling materials;
- (c) unguarded machinery;
- (d) falls from heights;

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- (e) excessive temperatures/heat;
- (f) vibration;
- (g) ergonomics;
- (h) automation and remote movement;
- (i) inadequate inspection and prevention;
- (j) inadequate first aid, medical attention, emergency assistance;  
and
- (k) inadequate training.

### **5.2. Hazard identification, risk assessment and control**

#### **5.2.1. General principles**

5.2.1.1. The employer should have a system in place, in consultation with workers and their representatives, to identify hazards and assess risks to safety and health and apply control measures in the following order of priority:

- (a) eliminate the risk;
- (b) control the risk at source, such as substitution or engineering controls;
- (c) minimize the risk by means that include the design of safe work systems; and
- (d) in so far as the risk remains, provide for the use of personal protective equipment (PPE),

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

5.2.1.2. In giving effect to the above, the employer should establish, implement and maintain documented procedures to ensure that the following activities take place:

- (a) hazard identification;

- (b) risk assessment;
- (c) control of risks; and
- (d) a process to monitor and evaluate the effectiveness of these activities.

### 5.2.2. Hazard identification

5.2.2.1. The identification of hazards in the workplace should take into account:

- (a) the situation or events or combination of circumstances that have the potential to give rise to injury or illness;
- (b) the nature of potential injury or illness relevant to the activity, product or service;
- (c) past injuries, incidents and illness;
- (d) the way work is organized, managed and carried out and any related changes;
- (e) the design of workplaces, work processes, materials, plant and equipment;
- (f) the fabrication, installation, commissioning, handling and disposal of materials, workplaces, plant and equipment;
- (g) the purchasing of goods and services;
- (h) the contracting of plant, equipment, services and labour, including contract specification and contractors' responsibilities; and
- (i) the inspection, maintenance, testing, repair and replacement of plant and equipment.

### 5.2.3. Risk assessment

5.2.3.1. Risk assessments are used to determine the level of risk of injury or illness associated with each identified hazard, for the purpose of control. All risks should be assessed and have control

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priorities assigned, based on the assessed level of risk. The priority for control increases as the assessed level of risk increases.

5.2.3.2. Risk assessments should take account of the likelihood and severity of injury or illness from the identified hazard. There are many established methods and techniques for the purpose of risk assessment.

### **5.2.4. Risk control**

5.2.4.1. Unless a particular hazard or exposure to the hazard is removed, the risk associated with such a hazard can never be completely eliminated.

5.2.4.2. The employer should plan the management and control of those activities, products and services that can or may pose a significant risk to safety and health.

### **5.2.5. Evaluation**

5.2.5.1. The processes of hazard identification, risk assessment and control should be subject to a documented evaluation of effectiveness and modified as necessary, and therefore be an ongoing process.

5.2.5.2. Evaluations of hazard identification, risk assessment and control should take into consideration advances in technology, knowledge and experiences nationally and internationally.

### **5.2.6. Examples of application**

5.2.6.1. Chapter 6 contains specific examples of how this methodology can be applied in respect to a number of physical, chemical, safety and ergonomic hazards.

## **Prevention and protection**

5.2.6.2. Whilst the proper application of a hazard identification, risk assessment and control process should lead to acceptable safety and health outcomes, additional matters associated with the operation of an underground coalmine should be addressed. These are addressed in Part III of this code.



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**PART III. PROVISIONS FOR SAFE UNDERGROUND  
COALMINING OPERATIONS**

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## **6. General physical, chemical, safety and ergonomic hazards**

Where national laws, regulations and standards do not contain prescription or contain ineffective or outdated prescription as to general physical, chemical, safety and ergonomic hazards, this chapter provides guidance. The provisions outlined in this chapter, which include some reference to a hazard identification, risk assessment and control process, should be used in conjunction with the proper application of such a process.

The following provisions are provided as a guideline for safe underground coalmining operations.

### **6.1. Physical hazards**

#### **6.1.1. Noise**

##### **6.1.1.1. Hazard description**

6.1.1.1.1. Exposure to noise levels exceeding those determined to be safe can result in noise-induced hearing loss. Exposure to high noise levels may also interfere with communication and may result in nervous fatigue with an increased risk of occupational injury. Coalmines have confined spaces where workers are exposed to noise from all types of machinery and equipment used for drilling, cutting, loading and transporting coal and rock, for transporting supplies and material, and for moving volumes of mine air.

##### **6.1.1.2. Assessment of risk**

6.1.1.2.1. The level of noise and/or duration of exposure should not exceed the limits established by the competent authority or by other recognized standards. National laws or regulations should establish specific standards on noise levels permitted at coalmines

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based on internationally recognized findings. The assessment of risk should, as appropriate, consider:

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

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

- (a) identify the sources of noise and the tasks that give rise to exposure;
- (b) seek the advice of the competent authority and/or the occupational health service about exposure limits and other standards to be applied;
- (c) seek the advice of the supplier of processes and equipment used in the mine environment about expected noise emission; and
- (d) if this advice is incomplete or in doubt, arrange for measurements by competent professionals in accordance with current nationally and/or internationally recognized standards and regulations.

6.1.1.2.3. Noise measurements should be used to:

- (a) quantify the level and duration of exposure of workers and compare it with exposure limits, as established by the competent authority or internationally recognized standards to be applied;
- (b) identify and characterize the sources of noise and exposed workers;

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- (c) create a noise map for the determination of risk areas;
- (d) assess the need both for engineering noise prevention and control, and for other appropriate measures and their effective implementation; and
- (e) evaluate the effectiveness of existing noise prevention and control measures.

### 6.1.1.3. Control strategies

#### 6.1.1.3.1. General

6.1.1.3.1.1. Based on the assessment of the exposure to noise in the working environment, the employer should establish a noise-prevention programme with the aim of eliminating the hazard or risk, or reducing it to the lowest practicable level by all appropriate means. The employer should review the effectiveness of any engineering and administrative controls to identify and correct any deficiencies. If a miner's noise exposure exceeds the permissible exposure level, the employer should use all feasible engineering and administrative controls to reduce the miner's noise exposure to the permissible exposure level, and enrol the miner in a hearing conservation programme that would include:

- (a) audiometric testing;
- (b) training and education on hearing loss;
- (c) providing hearing protection that is effective;
- (d) conducting additional noise measurements to determine continued exposure; and
- (e) the ongoing examination of methods and controls to lower the noise levels causing the overexposure.

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### *6.1.1.3.2. Workers' health surveillance, training and information*

6.1.1.3.2.1. Workers who may be exposed to noise levels exceeding occupational standards should receive regular audiometric testing.

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

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

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

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

### *6.1.1.3.3. Hazard control methods*

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

- (a) specify low noise output of the process and equipment as a condition of purchase alongside production-related specifications; and

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- (b) arrange the workplace layout to minimize noise exposure to the workers.

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

6.1.1.3.3.3. If the elimination of noisy processes and equipment as a whole is impracticable, 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.

6.1.1.3.3.4. 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 standards and regulations.

6.1.1.3.3.5. 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. Barriers should be designed and manufactured in accordance with the

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requirements and needs indicated by the user, consistent with internationally recognized standards.

6.1.1.3.3.6. 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:

- (a) install an acoustical booth or shelter for those job activities where workers' movement is confined to a relatively small area;
- (b) minimize, by appropriate organizational measures, the time workers spend in the noisy environment;
- (c) provide hearing protection; and
- (d) offer audiometric testing.

### **6.1.2. Vibration**

#### **6.1.2.1. Hazard description**

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

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

6.1.2.1.2. Exposure limits should be established according to current international knowledge and data. Further detailed information can be found in Annex IV, section 7.

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### 6.1.2.2. Assessment of risk

6.1.2.2.1. If workers 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 and reduce them in accordance with the priorities established in 6.1.1.2. For the prevention of adverse effects of vibration on workers, employers should:

- (a) identify the sources of vibration and the tasks that give rise to exposure;
- (b) seek the advice of the competent authority about exposure limits and other standards to be applied;
- (c) seek the advice of the supplier of vehicles and equipment about their vibration emissions; and
- (d) if this advice is incomplete or in doubt, arrange for measurements by a competent person, in accordance with recognized standards and regulations and currently available knowledge.

### 6.1.2.2.2. Vibration measurements should be used to:

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

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

- (a) the high-risk use of tools can be eliminated;
- (b) workers have had sufficient training in the use of the tools; and
- (c) the use of tools can be improved by supports.

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

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

### 6.1.2.3. Control strategies

#### *6.1.2.3.1. Training and information*

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

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

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### *6.1.2.3.2. Hazard control methods*

#### 6.1.2.3.2.1. Manufacturers should:

- (a) provide vibration values for their tools;
- (b) redesign processes to avoid the need to use vibrating tools;
- (c) provide information to ensure that vibration is controlled by correct installation;
- (d) avoid resonance frequencies of the component parts of machinery and equipment;
- (e) consider including remote control capabilities in equipment that causes vibration hazards; and
- (f) use, where practicable, anti-vibration handles.

6.1.2.3.2.2. When purchasing equipment and industrial vehicles, employers should ascertain that the vibration exposure to the user is within prescribed national standards and regulations.

6.1.2.3.2.3. 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.

6.1.2.3.2.4. 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.

6.1.2.3.2.5. 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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6.1.2.3.2.6. Machinery or vibrating tools should be maintained regularly because worn components may increase vibration levels.

6.1.2.3.2.7. Where the exposure might lead to injury if workers continue work for a longer period, 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.

### **6.1.3. Heat and cold stress**

#### **6.1.3.1. Hazard description**

6.1.3.1.1. Risks arise in special conditions including when:

- (a) temperature and/or humidity are/is unusually high;
- (b) workers are exposed to high radiant heat;
- (c) high temperatures and/or humidity occur in combination with heavy protective clothing or a high work rate;
- (d) temperature is unusually low;
- (e) high wind speed (>5m/s) prevails with low temperature; or
- (f) work with bare hands is carried out for extended periods of time at low temperatures.

#### **6.1.3.2. Assessment of risk**

6.1.3.2.1. If workers are exposed in all or some of their tasks to any conditions listed in paragraph 6.1.3.1.1, and the hazard cannot be eliminated, employers should assess the hazards and risks to safety and health from extreme temperatures, and determine the controls necessary to remove the hazards or risks or to reduce them to the lowest practicable level.

6.1.3.2.2. Workers should be allowed sufficient time to acclimatize to a hot environment, including major changes in climatic conditions.

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

- (a) the use of protective clothing against hazardous substances, thereby increasing the risk of heat stress; and
- (b) a hot environment that makes respiratory protectors uncomfortable and less likely to be used, and that necessitates restructuring of jobs in order to reduce the risks, for example by:
  - (i) minimizing exposure to the hazardous substances so that there is less need for protective clothing;
  - (ii) changing the tasks so that the work pace is reduced in hot conditions; and
  - (iii) increasing the number of rest periods and job rotation.

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

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

### 6.1.3.3. Control strategies

#### *6.1.3.3.1. Training and information*

6.1.3.3.1.1. Workers exposed to heat or cold, as well as their supervisory officials, should be trained:

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

6.1.3.3.1.2. Workers should be advised of:

- (a) the importance of physical fitness for work in hot or cold environments; and
- (b) the importance of drinking sufficient quantities of a suitable liquid and the dietary requirements providing intake of salt and potassium and other elements that are depleted due to sweating.

### *6.1.3.3.2. Hazard control methods*

6.1.3.3.2.1. When the assessment reveals that the workers may be at risk of heat stress or hypothermia, employers should, as far as practicable, eliminate the need for work in such conditions or take measures to reduce the risks from extreme temperatures.

6.1.3.3.2.2. 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.

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

6.1.3.3.2.4. Where part of the risk arises from the metabolic heat produced during work, and other methods of eliminating the risk are impracticable, employers should arrange a work-rest cycle for exposed workers, either in the workplace or in a cooler rest-

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room. The rest periods should be as prescribed by the competent authority and sufficient to allow the worker to recover. Employers should ensure that the appropriate mechanical aids are available to reduce workloads and that tasks performed in hot environments are well designed ergonomically to minimize physical stress.

6.1.3.3.2.5. For hydration maintenance, employers should make available sufficient quantities of drinking water, with the proper electrolytes, where appropriate.

6.1.3.3.2.6. 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.

6.1.3.3.2.7. 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.

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

6.1.3.3.2.9. 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.

## **6.2. Chemical hazards**

### **6.2.1. Chemicals in the workplace**

#### **6.2.1.1. Hazard description**

6.2.1.1.1. A chemical substance is a compound or mixture which may be present in the workplace in the form of a liquid, solid

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(including particles) or gas (vapour). 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.

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

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

### 6.2.1.2. Assessment of risk

6.2.1.2.1. Workers may be exposed to chemicals, by-products, materials or agents used in the workplace, particularly in the confined space of underground mines. Solvents and cleaners, polyurethane sprays, roof glues, emulsion fluids and many other products used in coalmines may be hazardous.

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

6.2.1.2.3. The advice of the competent authority should be sought regarding exposure limits and other standards to be applied.

6.2.1.2.4. Material safety data sheets (MSDS) 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. The *Globally Harmonized System of Classification and Labelling of Chemicals* (GHS) (United Nations, 2003) provides guidance on the preparation of labels, MSDS and the provision of information to workers.

6.2.1.2.5. The production of material safety data sheets in electronic format should be encouraged. Chemical safety data sheets

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

- (a) identification of manufacturer, product and ingredients;
- (b) physical and chemical properties, and information on the health effects, physical hazards, environmental impact and relevant exposure limits; and
- (c) recommendations concerning safe work practices; transport, storage and handling; waste disposal; protective clothing and PPE; first aid, firefighting and chemical spills.

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

- (a) signal word or symbol; identification information, including the manufacturer, product and ingredients;
- (b) risks and safety phrases, first-aid and disposal procedures; and
- (c) reference to the MSDS and the date of issue.

6.2.1.2.7. 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.

### 6.2.1.3. Control strategies

#### 6.2.1.3.1. Training and information

6.2.1.3.1.1. Each employer should:

- (a) identify the chemicals used at the mine;
- (b) determine which chemicals are hazardous;
- (c) establish a hazard communication programme;
- (d) inform each worker who could be exposed about the hazards related to the chemicals, and inform other on-site employers

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whose workers could be exposed about chemical hazards and appropriate protective measures;

- (e) ensure workers and/or trained first-aid personnel are aware of emergency procedures related to exposure to hazardous chemicals; and
- (f) provide workers with the necessary training and protection to prevent exposure to hazards, including protective clothing.

6.2.1.3.1.2. Each employer should:

- (a) develop and implement a written hazard communication programme;
- (b) maintain it for as long as a hazardous chemical is known to be at the mine; and
- (c) share relevant information with other on-site employers whose miners could be affected.

6.2.1.3.1.3. The hazard communication programme should include the following:

- (1) how this part is put into practice at the mine through the use of:
  - (a) hazard determination;
  - (b) labels and other forms of warning;
  - (c) MSDS; and
  - (d) miner training;
- (2) a list or other records identifying all hazardous chemicals known to be at the mine, which should:
  - (a) use a chemical identity that permits cross-referencing between the list, a chemical's label, and its MSDS; and
  - (b) be compiled for the whole mine or by individual work areas;
- (3) at mines with more than one employer, the methods for:
  - (a) providing other employers with access to MSDS; and

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- (b) informing other employers about:
  - (i) hazardous chemicals to which their workers can be exposed;
  - (ii) the labelling system on the containers of these chemicals; and
  - (iii) appropriate protective measures.

6.2.1.3.1.4. The employer should:

- (a) ensure that each container of a hazardous chemical has a label listing the ingredients and the appropriate hazard warnings; and
- (b) have an MSDS for each hazardous chemical used at the mine which lists the chemical's hazards and protective measures.

6.2.1.3.1.5. The employer should make current MSDS readily available and accessible to workers during each work shift for each hazardous chemical to which they may be exposed.

### 6.2.1.3.2. Hazard control methods

6.2.1.3.2.1. The employer should ensure:

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

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- (d) that emergency showers and eyewash stations are available where hazardous chemicals are used and/or stored;
- (e) the cleaning of work clothes that have been polluted by chemicals; and
- (f) the provision of appropriate hygienic conditions in facilities where food is consumed.

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

#### 6.2.2.1. Hazard description

6.2.2.1.1. The production of coal, including the supplies, materials and resources taken into the mine, involves the generation of a variety of inhalable agents including, but not limited to, gases, vapours, dusts, fumes, smokes and aerosols. These agents can comprise a variety of toxicological hazards including irritants, chemical asphyxiants, fibrogens, allergens, carcinogens and systemic toxicants. The most common of the airborne contaminants are respirable coal dust and crystalline silica, generated from fractured rock in the mine.

6.2.2.1.2. The pulmonary system (lungs) can be affected by exposure to harmful agents, such as coalmine dusts (which are covered in more detail in Chapter 8) through acute (short-term) injury to lung tissue, the development of pneumoconiosis and pulmonary dysfunction. Some airborne contaminants can lead to the development of lung cancer. Certain harmful agents that are inhaled can cause target organ damage and/or systemic toxic effects. High concentrations of certain asphyxiants can cause death in a few seconds by displacing oxygen.

6.2.2.1.3. The confined space of an underground coalmine and the ventilation currents that flow through it can carry airborne contaminants. Solvents and cleaners, polyurethane sprays, roof glues,

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emulsion fluids and other products used in coalmines may contain such hazards. The pollutants from diesel exhaust, high levels of carbon dioxide or methane from unventilated areas of a mine also pose inhalable hazards.

### 6.2.2.2. Assessment of risk

6.2.2.2.1. The assessment of risk should begin with a review of the gases and dusts generated as part of the mining process and products and agents used at and taken into coalmines, in order to understand the content, form and volume of inhalable agents. The information acquired through implementation of the hazard communication programme in section 6.2.1.3.1.3, including information from suppliers for materials brought on site and use of MSDS, should provide considerable information about the hazards. Examinations and sampling of the mine air will provide information on potential inhalant hazards.

6.2.2.2.2. The potential for exposure should be assessed according to the provisions of 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.

6.2.2.2.3. Exposure assessment activities should be conducted by competent persons.

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

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

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### 6.2.2.3. Control strategies

#### 6.2.2.3.1. *Training and information*

6.2.2.3.1.1. The provisions contained in section 6.2.1.3 regarding protections against chemical hazards and the hazard communication programme should be applied to protect workers from inhalable agents. Protection from respirable coalmine dusts (Chapter 8) and provisions to protect against noxious or harmful mine gases (Chapter 21) should be implemented.

6.2.2.3.1.2. Workers and their representatives should be made aware of the toxicological properties, technical means of prevention, 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 into contact should be minimized.

6.2.2.3.1.3. Training should be provided in advance of work that results in the use or generation of inhalable agents.

6.2.2.3.1.4. Training should specify special precautions to be taken for workers who perform work in confined spaces that might contain harmful inhalable agents.

#### 6.2.2.3.2. *Hazard control methods*

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

6.2.2.3.2.2. 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.

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

6.2.2.3.3.1. 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.

6.2.2.3.3.2. 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.

## 6.3. Safety hazards

### 6.3.1. Falling materials

6.3.1.1. Falling materials are a major hazard in coalmines. The most common are falls of the coalmine roof, coalfaces (headings) and sides (ribs) including outbursts of coal and rock. Each employer should develop and follow a roof, face and side control plan, approved by the competent authority, that is suitable for the prevailing geological conditions and the mining system to be used at the mine. Additional measures should be taken to protect persons if unusual hazards are encountered.

6.3.1.2. The employer should ensure that the roof, face and side of areas where persons work or travel are supported or otherwise controlled to protect persons from hazards related to falls of the roof, face or ribs and coal or rock bursts.

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6.3.1.3. No person should work or travel under an unsupported mine roof unless approved by the competent authority. Control measures for the mine roof, coalfaces and sides are covered in greater detail in Chapter 20.

6.3.1.4. The employer should control the general risk of falling materials 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 materials:

- (a) take all necessary steps to prevent materials or objects falling;
- (b) keep areas clean, in good working order and well maintained to prevent the accumulation of process materials that could subsequently fall;
- (c) ensure the use of covered walkways or alternative safeguards such as safety nets;
- (d) schedule required overhead maintenance when there is the smallest 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 and providing warning signs; and
- (e) prevent access to areas where there is a risk of falling objects, except in an emergency.

### **6.3.2. Slips, trips and falls**

6.3.2.1. Slips, trips and falls are a common hazard in coalmining. Walkways underground, in particular, can be obstructed with the debris of coal sides, material spilled during transport, materials and supplies cluttering confined working places and the wet and sloped floor of the mine.

6.3.2.2. Each employer should have a mine maintenance, housekeeping, clean-up plan in place which has:

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- (a) the travel ways and walkways inspected frequently for obstructions;
- (b) routine clean-up and maintenance to keep the travel ways and walkways free of slip, trip and fall hazards; and
- (c) a housekeeping plan that has mine supplies and materials properly placed at workplaces.

6.3.2.3. Employers should also ensure that:

- (a) floors are maintained regularly, and kept clean and free of oil spills, other slippery fluids or materials and obstructions;
- (b) pits and other floor openings are covered or cordoned off with clear warning signs when not in use, and are always well lit;
- (c) elevated points of access are provided with suitable and clearly marked platforms or walkways equipped with handrails and protective barriers;
- (d) platforms and walkways are accessible via permanent, fire-resistant elevators, stairways or ladders;
- (e) open-mesh walkways or platforms are fastened securely and constructed so that any apertures in the mesh are small enough to prevent objects from falling through and causing injury to people below;
- (f) platforms, walkways and stairways with open sides are provided with railings and panelling up to the height of the railings or kick boards or toe boards extending part-way up the railings; and
- (g) hinged covers are provided at openings in elevated walkways or platforms that are designed to carry intended loads, are kept closed when not in use and are suitably guarded when in use.

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### **6.4. Ergonomic hazards**

#### **6.4.1. Hazard description**

6.4.1.1. The risk of musculoskeletal injuries exists in industries where repetitive motions and manual labour are common. Manual carrying and lifting of large, bulky and/or heavy objects is common in coalmining, and can cause musculoskeletal injuries.

6.4.1.2. Long-lasting repetitive work movements and awkward postures may cause musculoskeletal injuries. Maintaining the same posture for extended periods causes excessive fatigue.

6.4.1.3. Repetitive work and tasks with little variety and/or few events may lead to boredom and errors being made.

6.4.1.4. Confusing and/or missing information may lead to errors being made.

6.4.1.5. Too high a physical load may cause excessive fatigue, especially in a hot environment (see paragraph 6.1.3).

6.4.1.6. The conveying of visual and acoustic information may be degraded because of environmental factors, poor design of machinery and equipment, and inappropriate or incorrectly used PPE may lead to dangerous incidents and accidents.

#### **6.4.2. Assessment of risk**

6.4.2.1. Measures should be taken to ensure the appropriate selection and design of tools, machines, equipment and workstations, including PPE.

6.4.2.2. The competent authority, after consulting the representative organizations of employers and workers concerned, should establish OSH requirements for repetitive work, working postures, physical load and the handling and transport of materials, particularly manual handling. Such requirements should be used in

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risk assessment, technical standards and medical opinions, taking account of the relevant conditions in which the work is performed.

6.4.2.3. Workers should receive all the necessary information about the process, machinery and their co-workers in correct form and in due time. Receipt of this information should be verified. Temporary work phases should be checked and temporary workers informed.

### **6.4.3. Control strategies**

6.4.3.1. An appropriate ergonomic study should be undertaken to investigate jobs and tasks while workers are carrying out various operations. The study should focus on heavy physical work, work postures, work movements (especially repetitive movements), lifting and pushing/pulling heavy loads. The impact of the working environment on the worker and the functional design of the machinery should be explored.

6.4.3.2. To the extent possible, the task should be adapted to the worker, and the jobs and tasks with unacceptable ergonomic problems should be eliminated by redesigning work procedures, workstations, tools and machinery.

6.4.3.3. If complete elimination is not practicable, the time that workers are required to spend in such conditions should be as short as possible. The workload may be brought to a tolerable level with sufficient rest periods and job rotations. Changes in posture should be possible.

6.4.3.4. Workers should be trained in using correct work techniques.

6.4.3.5. Workers should be informed about the hazards related to physical work, work postures, repetitive movements and lifting and carrying loads.

## **7. Flammable coal dust**

Where national laws, regulations and standards do not contain prescription or contain ineffective or outdated prescription as to flammable coal dust, this chapter provides guidance. The provisions outlined in this chapter, which include some reference to a hazard identification, risk assessment and control process, should be used in conjunction with the proper application of such a process.

### **7.1. Hazard description**

7.1.1. The production, transportation and processing of coal generates small particles of coal dust. If uncontrolled and allowed to accumulate, that highly explosive dust can ignite. If it becomes airborne the coal dust can cause violent explosions. Coal dust explosions can create deadly forces, fire and super-heated air which can quickly spread through a mine, killing or injuring several miners. Explosion forces can destroy ventilation and roof controls, block escape routes and trap miners in conditions where oxygen in the mine air is replaced with asphyxiating gases.

### **7.2. Hazard control**

7.2.1. Coal dust explosions can be prevented by mine maintenance (clean-up of coalmine dust), adding sufficient stone dust to render the coal dust inert, and by eliminating ignition sources. Explosion effects can also be mitigated by using barriers to suppress propagating explosions.

7.2.2. National laws or regulations should state the minimum percentages of incombustible material to be maintained in the mine with special emphasis: at, or near, coalfaces and working places; in intake and return air courses; on roadways; and in conveyor belt entries.

7.2.3. Stone dust should be applied to the mine floor, sides and top throughout the mine and as close to the coalface as possible, with incombustible content at levels to prevent coal-dust explosions.

7.2.4. (1) The stone dust used for this purpose should be tested by standards set by a competent authority to ensure it is harmless to health.

(2) It should also possess the properties, degree of fineness and the dispersibility as specified in laws or regulations.

(3) Intervals at which the stone dust must be tested for compliance with these requirements should also be specified in laws or regulations.

7.2.5. A dust register should be used to record details of these tests, including the place and date of sampling, the amount of incombustible material in the samples and the date of treatment of different areas of the mine.

7.2.6. (1) National laws or regulations should require frequent inspections and clean-up programmes for coal spillage and coal dust throughout the mine, with special emphasis on coalfaces, roadways, conveyor belt entries and returns.

(2) The inspections and clean-up programmes should ensure quick removal of coal spillage and dust, and application of stone dust.

(3) Conveyor entries should be kept free of ignition sources such as friction from conveyor rollers and belting.

(4) Energized equipment and circuits, diesel equipment, other potential ignition sources and elevated structures should be inspected for deposits of coal dust.

(5) Where deemed necessary, stone-dusting may be supplemented by the use of dust-consolidation materials, which can be

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applied to the roadway to prevent dust rising into the ventilation current.

7.2.7. It should be the duty of the manager of every mine to ensure that:

- (a) all practicable measures are taken in the extraction, transportation and preparation of minerals to minimize emission of flammable dust;
- (b) where such dust is emitted into the mine atmosphere, either below ground or on the surface, measures are to be taken to ensure that the dust is trapped as near as possible to the point of origin;
- (c) accumulations of flammable dust are cleaned up and transported out of the mine or rendered harmless without delay; and
- (d) stone dust or other incombustible material is applied to render coal dust inert.

7.2.8. (1) No plant for screening, processing or sorting coal should be placed within 80 metres (approximately 260 feet) of a downcast shaft, drift or opening unless national laws or regulations allow otherwise.

(2) In any event, the necessary measures should be taken to minimize the possibility of dust entering the downcast air stream.

7.2.9. Vehicles and haulage equipment used for the transport of minerals should be maintained in good condition so as to minimize spillage.

7.2.10. Conveyor equipment should be so constructed that the risk of dust deposition is minimized.

7.2.11. Continuous stone-dusting machines should be used to apply stone dust in the immediate returns of districts/sections and

particularly on longwalls, to maintain incombustible content at levels to prevent coal-dust explosions.

### **7.3. Means of arresting explosions**

7.3.1. (1) National laws or regulations should specify the measures to be taken to arrest any explosion which may occur in a mine.

(2) Included in these measures should be the installation of stone-dust or water barriers.

7.3.2. (1) National laws or regulations should specify the places in a mine where barriers should be placed for the purpose of arresting and minimizing the effect of an explosion.

(2) For these purposes, national laws or regulations should specify maximum and minimum distances from the first working place in any ventilating district at which barriers should be maintained.

7.3.3. National laws or regulations should approve and specify the types of stone-dust or water barrier to be installed below ground.

7.3.4. (1) The manager of every mine should prepare an explosion-barrier scheme for the mine, which complies with national laws and regulations regarding barriers.

(2) This scheme should include the installation of barriers in roadways where coal is transported and in any other roadways where the manager may determine that flame is likely to extend.

7.3.5. The position of all barriers should be shown on the ventilation and rescue plans.

7.3.6. Barriers should be maintained with a sufficient quantity of suitable dust or water, and with enough clearance between the roof and sides of the roadway to allow them to operate efficiently.

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7.3.7. Nothing in this code should prevent the use of triggered barriers in conditions to be agreed between management, workers' representatives and the competent authority.

7.3.8. Relevant information regarding the movement and maintenance of barriers should be kept in the dust register required by paragraph 7.2.5.

## 8. Respirable dust

Where national laws, regulations and standards do not contain prescription or contain ineffective or outdated prescription as to respirable dust, this chapter provides guidance. The provisions outlined in this chapter, which include some reference to a hazard identification, risk assessment and control process, should be used in conjunction with the proper application of such a process.

### 8.1. Hazard description

8.1.1. The production, transportation and processing of coal generates tiny respirable coal dust particles that become airborne and are invisible to the naked eye. Appropriate instrumentation should be used to quantify the level and size of dust particles present in the air. Coal is made up of a variety of elements. It is mixed with other dusts, most notably crystalline silica, generated from fractured rock in the mine roof, floor or the coal seam, which can also become airborne.

8.1.2. Coalmine dusts can be a significant health risk. When inhaled by miners, dust can result in diseases of the pulmonary system (lungs), including coalworkers' pneumoconiosis, progressive massive fibrosis, silicosis and chronic obstructive pulmonary disease. These lung diseases are progressive, disabling and can be fatal.

### 8.2. Hazard control

8.2.1. Lung diseases from coalmine dusts can be prevented if respirable dust levels are maintained at levels below those considered unhealthy. Each employer should have in place: effective engineering controls to maintain respirable dusts at prescribed levels that will not be harmful to miners; periodic monitoring of workplaces by inspecting the engineering dust controls and sampling the

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airborne respirable dusts to ensure they are maintained at safe levels; a medical surveillance programme to monitor miners' health; a programme for moving miners to less dusty areas, including miners with evidence of lung disease; and, as a secondary means of protection, proper fitting respirators that effectively filter unhealthy dusts.

### **8.3. Prevention and suppression of respirable dust**

8.3.1. (1) National laws or regulations should require, and it should be the duty of the manager of every mine to establish, a respirable dust control plan which provides engineering controls and other equipment to minimize emissions of dust and to suppress dust which enters the mine air; as an additional protection, work procedures to minimize exposure should be established and proper respiratory equipment be provided.

(2) Engineering controls to suppress mine dusts should include the combination of ventilation, water and water sprays, dust collection and filtering devices, and safe dust allaying agents. Administrative controls to replace miners during shifts and move miners to less dusty areas should also be considered as a means to reduce exposure to unhealthy dust.

(3) Every such respirable dust control plan should cover:

- (a) the engineering controls, devices, equipment, procedures and methods to be utilized in the suppression of respirable mine dusts;
- (b) the systematic examination and testing of the engineering controls, devices, equipment procedures and methods to ensure proper maintenance and efficient operation;
- (c) the use of respiratory equipment, including proper selection and training in the use and care of the devices; and
- (d) the appointment of a properly trained and competent person to be in charge of the respirable dust control plan.

8.3.2. Engineering controls that should be considered are:

- (a) water sprays on cutting heads of coal-cutting and continuous mining machines spraying dust as it is released at the face;
- (b) scrubber fans mounted as part of the coal-cutting and continuous mining machine to filter and control dust around the machine and assist in ventilating a working place at an underground mine;
- (c) water sprays on longwall shearers spraying dust as it is released at the face;
- (d) mist water sprays located on the top of longwall shields which activate when the shield is lowered from the mine roof and advanced;
- (e) water infusion in longwall coal blocks in advance of mining;
- (f) dust collectors mounted on roof drilling machines or water pressured through drill stems to the cutting bits;
- (g) dust collection systems or dust suppression water sprays on longwall stageloaders/crushers; and
- (h) dust suppression water sprays at conveyor-belt drives, transfer points and strategic locations on conveyor-belt structures.

8.3.3. (1) A person designated by the mine manager should conduct examinations each shift to ensure that the respirable dust control parameters specified in the mine ventilation plan are effectively working.

(2) Deficiencies in dust controls should be corrected immediately.

(3) The examination should include air quantities and velocities, water pressures and flow rates, excessive leakage in the water delivery system, water spray numbers and orientations, district/section ventilation and control device placement, and any other dust suppression measures required by the respirable dust control plan.

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(4) It should suffice if the air velocity and quantity, water pressure and flow rates are continuously monitored and are used to determine if the dust controls are functioning properly.

8.3.4. No person should use any machinery or equipment unless it is equipped with properly operating dust prevention and suppression devices as specified in paragraphs 8.3.1 and 8.3.2.

8.3.5. No person should tamper with, remove or otherwise interfere with, any dust prevention or suppression devices unless authorized to do so by the manager of the mine.

### **8.4. Sampling of respirable dust**

8.4.1. (1) National laws or regulations should establish a plan for the sampling of the air in relation to the mining operations and miners' exposure, and it should be the duty of the manager of every mine to carry out an effective dust sampling plan.

(2) Each sample taken should be representative of the general body of air in the vicinity of the mining operation being sampled where miners work and breathe and, where applicable, should be made by a method of personal sampling.

(3) The sample should also be taken continuously throughout the shift during which the normal coal extraction and production operations are in progress.

(4) Where personal respirable dust sampling is conducted, to ensure a representative sample of the miners' routine exposure, miners should be performing their normal work at their regular work locations.

(5) The intervals at which samples are taken should be related to the method of mining and potential dust exposures of miners, but should not exceed two months.

(6) Modern methods of continuously sampling airborne respirable coalmine dust that miners are exposed to, which provide real-time exposure results of dust levels, should be pursued and implemented.

(7) Dust determination should be carried out at a properly equipped laboratory as soon as practicable after receipt of the sample, or by a secure process from devices that provide instantaneous results, as approved by the competent authority.

(8) The plan should also cover:

- (a) the sampling equipment to be provided, which should be of a type approved by, or conform to specifications set out by, the competent authority;
- (b) the positions and frequency at which the samples should be taken in relation to the method of extraction and potential dust exposures;
- (c) the arrangements for determining the respirable-dust and quartz content of the sample;
- (d) the arrangements for the systematic examination and testing of the sampling equipment so as to ensure its efficient maintenance and operation; and
- (e) the training and appointment of sufficient competent persons to operate the scheme effectively.

8.4.2. Miners' representatives should have the opportunity to participate in the development and implementation of the dust sampling process.

### 8.5. Allowable maximum respirable dust concentrations

8.5.1. (1) National laws or regulations should specify the allowable maximum dust concentration in a working place that miners can be exposed to.

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(2) Maximum permissible respirable dust concentrations should be specified in national laws and regulations after taking into account modern technology and scientific and medical research.

(3) In the absence of such national laws and regulations, the employer should put into place a dust control programme that effectively demonstrates the absence of dust-related illnesses or, as a minimum, continuously maintains the average concentration of respirable dust in the mine atmosphere during each shift to which each miner is exposed at or below the current applicable World Health Organization (WHO) standard.

8.5.2. (1) Maximum permissible respirable crystalline silica concentrations should be specified in national laws and regulations after taking into account modern technology and scientific and medical research.

(2) In the absence of such national laws and regulations, the employer should put into place a crystalline silica control programme that effectively demonstrates the absence of crystalline silica-related illnesses or, as a minimum, continuously maintains the average concentration of respirable crystalline silica in the mine atmosphere during each shift to which each miner is exposed at or below 0.1 mg per cubic metre.

8.5.3 The specified standards should be kept under review in consultation with representatives of employers' and workers' organizations.

8.5.4. In any mining operation where it is established through sampling that the dust concentrations exceed the allowable maximum, measures should be instituted to ensure that the required limits are complied with.

### **8.6. Provision of dust respirators**

8.6.1. (1) There should be provided, as a secondary means of protection at every mine, sufficient dust respirators of a type

approved by, or conform to specifications set out by, the competent authority for the use of persons engaged in the mining operations. Respirator use and care is covered in section 24.5.

(2) Such protection should be provided at no cost to the persons employed.

8.6.2. These dust respirators should be kept clean and maintained in efficient working order.

8.6.3. Proper fitting of respirators and thorough training in the use of respirators should be provided for each employee requiring the use of respirators.

## **8.7. Medical supervision**

8.7.1. (1) National laws and regulations should require, and the employer should prepare a plan for, the adequate medical supervision of the persons employed at the mine.

(2) The plan should also provide for a period of recuperation and convalescence where necessary.

(3) In particular, the plan should specify the arrangements for periodic chest radiography for each miner.

(4) In the evaluation of chest radiographs, reference should be made to the standard films of the International Classification of Radiographs of Pneumoconiosis of the ILO, and the ILO guidelines for their use.

8.7.2. Miners who are diagnosed with evidence of dust-related occupational diseases contained in 8.1.2 should be offered work in areas of the mining operation with the lowest levels of mine dust and without suffering pay loss.

8.7.3. Such medical supervision and recuperation should be provided at no cost to the persons employed.

## 9. Mine fires

Where national laws, regulations and standards do not contain prescription or contain ineffective or outdated prescription as to mine fires, this chapter provides guidance. The provisions outlined in this chapter, which include some reference to a hazard identification, risk assessment and control process, should be used in conjunction with the proper application of such a process.

### 9.1. Hazard description

9.1.1. Three ingredients are necessary for a fire. These are fuel, oxygen and heat, referred to as the fire triangle. Coal seams make up a third of the fire triangle with natural deposits of both solid and gaseous fuels. Mine ventilation carries oxygen, the second part of the fire triangle, throughout the mine. Electrical machines, equipment, lights, power stations and circuitry, along with diesel equipment, conveyor belting frictional sources, welding, acetylene cutting and other producers of friction, spark or flame used throughout a mine are heat sources which add the third ingredient of the fire triangle. To prevent the outbreak of coalmine fires, a number of critical safeguards, checks and balances are necessary.

9.1.2. Fires are a significant danger to the safety and health of mineworkers. Fires at underground mines place the lives and livelihood of miners at risk. Ventilation currents in underground mines can carry dense smoke and toxic combustion products from fires throughout the mine, making escape through miles of confined passageways difficult and deadly. Fires can quickly spread through a mine, destroying mine ventilation controls, trapping miners and triggering mine explosions with unlimited fuel supply and the presence of flammable methane.

## 9.2. Hazard control

9.2.1. National laws or regulations should require employers of each mine to have a fire prevention and emergency response plan that should be approved by the competent authority with the opportunity for review by miners' representatives. Each employer should have such a plan in place which would include the following components:

- (1) *Fire prevention* – This involves the methods, materials and equipment in place to prevent fires regarding: all energized equipment, vehicles and haulage equipment in the mine; welding or acetylene cutting operations; conveyor belting systems and structures where friction heat is possible; trolley wire entries; ventilation controls separating intake, haulage (including belt haulage) and return air courses; district/section coal-face extraction activities; spontaneous combustion; and other circumstances and information the competent authority would deem necessary.
- (2) *Fire warning* – This addresses the system in place to provide quick notification at the earliest stages of a potential fire and should include: strategic locations of mine communication devices; frequent physical examinations; and installation of monitoring devices at locations in the mine that are most susceptible to the occurrences of fires that would provide automatic warnings and alarms locally, and to a central facility on the mine surface. Monitors should be installed: in conveyor belt entries and particularly around belt drives, transfer points and at locations along conveyor belts; at unattended electrical equipment; in air courses ventilating haulage ways; at entries where trolley wire is installed; at locations where permanent electrical equipment is installed; on mining districts/sections; at strategic locations in return air courses; and at other locations the competent authority would deem necessary.

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- (3) *Firefighting equipment* – In all mines, as far as practicable, firefighting equipment and materials located throughout the mine should include: the type, locations and capacity of all firefighting equipment and devices in the mine, such as water lines, water deluge and sprays, water valves, water cars, fire hoses, fire extinguishers, dry powder chemical systems, foam generating systems, automatic fire suppression systems, district and coalface firefighting equipment and supplies; method and frequency of testing of the firefighting equipment; and other firefighting protections the competent authority would deem necessary.
- (4) *Fire and emergency response* – The specific response protections and procedures to be used at the mine include, as far as practicable, the number and location of self-contained self-rescuers or self-rescuer devices used by miners, along with the training and testing procedures used; description, location and training experience of mine rescue teams that are on standby to respond; locations of atmospheric monitoring sensor devices in the mine which measure mine gases, air flows and quantity; record of who is trained to respond to mine fires or mine emergencies on each shift in the mine; the description and frequency of firefighting training and fire and emergency evacuation drills; the specific procedures to be followed if a mine fire, explosion or other such event should occur; description of mine evacuation procedures – including immediate evacuation of the mine – and the methods and procedures for determining that conditions are safe for those who remain to fight, rescue or perform other actions, including a thorough examination of the emergency area; and other information and procedures the competent authority would deem necessary.

### 9.3. General provisions

9.3.1. It should be the duty of the employer and of the mine manager to:

- (a) plan, equip and work the mine so as to minimize the risk of fire;
- (b) take measures and precautions appropriate to the nature of a mine operation to prevent, detect and combat the start and spread of mine fires; and
- (c) ensure that, when there is serious danger to the safety and health of workers, operations are stopped and workers are evacuated to a safe location.

9.3.2. (1) The employer should provide, and national laws and regulations should require, a self-contained self-rescuer or at a minimum a self-rescue device of an approved type for all persons permitted to be below ground at the mine, along with training in their use.

(2) The manager should ensure, and national laws and regulations should require, that a plan is in force for using such devices and maintaining them in suitable condition.

9.3.3. In all mines, as far as practicable, there should be provided two main intake airways so separated that, if one becomes contaminated with the products of a fire, the other is clear for a safe means of escape from the mine for the person below ground.

9.3.4. In all mines, as far as practicable, two exits should be provided from every underground workplace, each of which is connected to separate means of egress to the surface.

9.3.5. In all mines where two main intake airways are not provided, the one main intake should, as far as practicable, be so constructed and equipped that it is free from the risk of fire.

9.3.6. All conveyor belting, sheeting and brattice should be of a fire-resistant type and approved by the competent authority.

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9.3.7. The manager of every mine should draw up a plan and should enforce rules for the organization and conduct of firefighting work and of fire drills.

9.3.8. The hydraulic fluid used in machinery should conform to standards as specified by laws and regulations or the competent authority.

9.3.9. The use of open flames or arcs for welding, steel cutting or any other purpose should be permitted under conditions which should be defined by the competent authority.

### **9.4. Fireproof construction**

9.4.1. All shaft linings in new installations should be made fire-proof as far as practicable.

9.4.2. The head frame and pit-head buildings should not be made of wood.

9.4.3. (1) Haulage rooms, engine rooms and workshops underground, together with their equipment, should be constructed in a fireproof manner.

(2) Such places should be provided with a second exit to minimize the risk of being trapped by fire.

9.4.4. Underground workshops, transformer stations, battery-charging stations, substations, compressor stations and permanent pumps should be housed in non-combustible structures or areas. Air currents used to ventilate structures or areas enclosing electrical installations should be coursed directly into the return air course. Other underground structures installed in a coalmine may need to be located in fireproof construction, as determined by the competent authority. These facilities should also be monitored by an atmospheric monitoring system (AMS) contained in section 21.12, and unattended enclosures should be designed with

doors that automatically close when sensors detect heat, smoke or carbon monoxide.

## 9.5. Firefighting equipment

9.5.1. (1) National laws or regulations should specify the requirements for the locations, amounts of and type of firefighting equipment, devices (including automatic fire sensor, warning device and detection systems) and materials to be located throughout coalmines, which each employer should ensure are in place.

(2) Unless exempt by virtue of national laws or regulations on the grounds of natural conditions or size, every mine should be equipped with a water mains circuit capable of delivering to all working places an adequate quantity of water at sufficient flow pressure for the purpose of efficient firefighting.

(3) Firefighting equipment, devices and materials should include water lines or water cars with sufficient water, or chemical cars with sufficient dry extinguishing chemicals supplies, fire extinguishers and stone dust in each district/section.

(4) In conveyor belt entries, specially designed water or foam spray or deluge systems or dry chemicals should be installed above each belt drive, belt take-up, electrical control and gear-reducing unit, and at other strategic locations on the conveyor belt system.

(5) Water lines should be installed parallel to the entire length of belt conveyors and should be equipped with fire-hose outlets with valves at 90-metre (approximately 295 feet) intervals along each belt conveyor and at tailpieces; with at least 150 metres (approximately 500 feet) of fire hose stored at strategic locations along the belt conveyor.

(6) Water lines should be installed parallel to all haulage tracks using mechanized equipment in the track or adjacent entry extending to the loading point of each working district/section, be

## **Safety and health in underground coalmines**

equipped with outlet valves at intervals of not more than 150 metres (approximately 500 feet), and 150 metres of fire hose provided at strategic locations. If water lines are not provided, sufficient portable water cars should be readily available.

(7) At least one portable fire extinguisher should be provided on each track or off-track locomotive, self-propelled person-trip car or personnel carrier.

(8) At least one portable fire extinguisher should be provided at each permanent electrical installation and each temporary electrical installation.

(9) At least one portable fire extinguisher or sufficient amounts of stone dust should be provided at locations where welding, cutting or soldering with arc or flame is being done.

(10) Portable fire extinguishers and other fire-suppression equipment should be provided in all parts of the mine where flammable material is stored, diesel maintenance workshops and fueling stations are located, and at workshops and other locations where fire protection is necessary.

9.5.2. (1) National laws or regulations should establish standards requiring automatic fire sensor and warning device systems to be used to actuate deluge-type water systems, foam generator systems, multipurpose dry-powder systems or other equivalent automatic fire suppression systems. These should be required for automatic fire suppression in conveyor-belt fire protection areas, on self-propelled equipment, coal-cutting loading and haulage equipment, underground transformer stations, battery-charging stations, substations, compressor stations and other electrical installations.

(2) Continuous mining machines and other face-cutting machines, loading machines and roof-bolting machines should be equipped with automatically operated fire suppression devices, particularly where the risk of frictional ignition is high.

9.5.3. Stations with a suitable supply of firefighting equipment should be established at convenient points both on the surface and underground. Emergency supplies should be placed in the mine at locations accessible to working districts/sections which contain boards, hand saws, claw hammers, sheets and nails to construct temporary stoppings or barricades, together with bags of cement and a large supply of stone dust.

9.5.4. (1) Fire extinguishers should be examined and discharged and refilled as often as may be necessary to ensure that they are kept in good working order.

(2) A record should be kept of each refilling.

9.5.5. Fire extinguishers which give off poisonous or noxious fumes should not be provided or used underground.

9.5.6. (1) At least once a month, or at shorter intervals if specified by national laws or regulations, all the equipment and material provided for firefighting should be examined by a competent person appointed by the employer.

(2) A report of each examination should be made by the competent person and any deficiencies remedied.

## **9.6. Storage of flammable materials**

9.6.1. Stocks of combustible or flammable material should not be stored in the vicinity of any shaft or outlet.

9.6.2. No oil, grease, canvas or other highly flammable material should be stored underground except in a fireproof receptacle or chamber, and only in limited quantities.

9.6.3. In underground workshops, engine rooms, motor rooms or transformer houses, greasy or oily waste should be placed in suitably designed and constructed receptacles and regularly removed from the mine.

## **Safety and health in underground coalmines**

9.6.4. At all places where combustible material may accumulate, the ventilation should be arranged to, where practicable, course the products of combustion from any fire directly into the return airway.

### **9.7. Precautions against spontaneous combustion of coal**

9.7.1. In mines subject to spontaneous combustion of coal the employer should develop procedures and protections to address the hazards that may be encountered. These should be made a part of the ventilation plan contained in section 21.2 and include:

- (a) the methods of working the coal seam, with the number of entries to a district/section minimized so as to facilitate its effective sealing;
- (b) the position of adequate supplies of suitable materials for seals;
- (c) the position of all firefighting equipment;
- (d) site preparations for establishing seals or stoppings underground;
- (e) the manner in which seals – where practicable, of the pressure-control type – or stoppings should be built to avoid the risk of leakage of atmosphere into or out of the sealed area; and
- (f) other safeguards that may be required by the competent authority.

9.7.2. Special inspections should be carried out regularly, especially following idle days, before work is resumed.

9.7.3. (1) Continuous monitoring as described in section 21.12 of the mine atmosphere should be in place at strategic places.

(2) The information should be communicated to the AMS control room on the surface of the mine.

(3) The person in charge of the AMS control room at the time should notify the management of any significant change in the content of the mine atmosphere being monitored.

## **9.8. Procedure in case of fire**

9.8.1. Each mine should develop and effectively communicate to all affected persons an emergency procedure covering the elements in section 9.2 to be implemented as part of the fire prevention and emergency response plan contained in paragraph 9.2.1 in case of outbreak of fire.

9.8.2. Where any smoke or other sign is noticed which indicates that a fire may have broken out below ground, the person detecting it should warn the nearest supervisory official immediately. Each mine should have procedures in place identifying the persons who should be immediately notified in case of such emergencies. If the signs of fire are detected by sensors being monitored on the surface, those affected underground should be notified immediately.

9.8.3. (1) When any fire occurs below ground, the person who notices it should, if possible, try to extinguish it and notify the appropriate mining officials as soon as possible.

(2) The competent authority should be notified without delay.

9.8.4. Suitable precautions should be taken to prevent danger to persons from any noxious, asphyxiating or flammable gases or smoke emanating from any fire.

9.8.5. (1) All persons, except those directed by the employer or other supervisory official of the mine to stay for the purpose of dealing with the emergency, should be withdrawn without delay from all areas affected by fire or smoke. Those who remain should be miners and supervisory officials who have received special training and are properly equipped to respond to and fight such fires.

## **Safety and health in underground coalmines**

(2) Thereafter only specially authorized persons should enter the mine. Mine rescue teams should be immediately contacted to replace the firefighting operation.

9.8.6. Where reasonably practicable, all accessible parts of the mine contiguous to the fire should be treated with stone dust or in some other way designed to prevent the spread of fire.

9.8.7. (1) The employer should make preparatory arrangements when sealing operations become necessary, for all or part of the mine so that they can be done safely.

(2) Only persons engaged in the sealing operations should be permitted below ground until the mine has been declared safe.

(3) Where practicable, at least one of the surface-entry seals should include an airlock to allow entry to or exit from the mine.

9.8.8. Where seals are erected to contain the fire, provision should be made for sampling the atmosphere from behind them, and drawing samples and monitoring the results from a safe location on the surface.

9.8.9. Once an emergency occurs that disrupts normal operations, such as a mine fire, the employer should immediately develop a safe emergency response plan broken down into separate steps. Provisions for mine emergency responses are outlined in more detail in sections 25.2 and 25.3. The competent authority should have the authority to review, amend if necessary and approve such plans, and miners' representatives should be afforded the opportunity to participate in that process.

### **9.9. Procedure for reopening a mine or area of a mine which has been sealed**

9.9.1. Before any seals are reopened, the competent authority should be notified and the plan for reopening agreed to and

approved. Representatives should be afforded the opportunity to participate in that process.

9.9.2. The reopening of mines or areas of mines which have been sealed should be permitted only when it has been established, by means of samples and other relevant data, that the fire has been extinguished and that increased oxygen or the temperatures behind the seals are not likely to cause a resurgence of the fire when the seals are opened.

## **10. Inrushes of water, gas or other material**

Where national laws, regulations and standards do not contain prescription or contain ineffective or outdated prescription as to inrushes of water, gas or other material, this chapter provides guidance. The provisions outlined in this chapter, which include some reference to a hazard identification, risk assessment and control process, should be used in conjunction with the proper application of such a process.

### **10.1. Hazard description**

10.1.1. Inrushes of water, noxious or flammable gas or other materials are a serious hazard in coalmining. Mining operations can get too close to old workings or geological abnormalities that contain water, gases or materials that could inundate the mine. One particular hazard is mining next to old workings that were poorly surveyed, not surveyed at all or not adequately inspected, which contain bodies of water or dangerous mine gases. Old workings filled with water, particularly at elevations higher than the active mine, could quickly flood the mine and drown miners before they could escape, if inadvertently cut into. Inrushing mine gases inadvertently encountered can overpower mine ventilation and the oxygen in the air and suffocate miners or, with the right mixture of oxygen, trigger explosions.

### **10.2. Hazard control**

#### **10.2.1. General provisions**

10.2.1.1. National laws or regulations should require competent authorities to maintain a national depository of all mining maps that includes the pertinent provisions of Chapters 15 and 16 and require employers to develop a plan subject to the approval of

### **Inrushes of water, gas or other material**

the competent authority, when mining near old workings, water-bearing strata or materials that may pose a hazard.

10.2.1.2. Those national laws or regulations should require employers to maintain solid barriers of coal or rock strata as necessary to protect persons in the mine and to conduct effective test drilling in advance of workings.

10.2.1.3. (1) It should be the duty of every employer to acquire from the national depository, and any other source, information that may be available regarding any previous mining near where mining will occur; to conduct all necessary drilling for core samples and test holes to analyse the strata to verify safe mining conditions; and to record on the mine plans all useful information concerning the location, extent and depth of:

- (a) old workings, whether coalmine workings or not, and the accuracy of surveys of those workings;
- (b) water-bearing strata; and
- (c) any peat, moss, sand, gravel, silt, salt or other material which flows when wet and which may exist in or near their mines.

(2) The employer should inform all persons who may be affected of all available and relevant findings and the actions that have been taken in each respect.

10.2.1.4. When the potential existence of the water, materials or old workings listed in paragraph 10.2.1.3, or other such hazards has been established near to the mine, it should be the duty of the employer to prepare a plan of working designed to prevent an inrush of water, other material or gas that may put the mine or persons at risk. This plan should include:

- (a) the specific methods to test in advance of these potential hazards, including advance test drilling with long-distance

## **Safety and health in underground coalmines**

- advanced drilling where inaccuracies may exist in relation to old workings, water, mine gases or other hazardous materials;
- (b) more frequent examinations of the areas being mined;
  - (c) the solid barriers to be maintained between the mine and hazards; and
  - (d) training for workers who may be affected by the plan of working and dangers.

10.2.1.5. A copy of the plan should be sent to the competent authority for approval. Before the plan is put into operation, the competent authority should have the duty of examining it and requiring any amendments necessary in the interests of safety before approving it.

### **10.3. Working under the sea or other body of water**

10.3.1. Where mine workings are being carried out, or are proposed to be carried out, in the vicinity of a sea, lake, river or other body of water, the employer should have the duty to ascertain:

- (a) the total thickness of strata between the mine workings and the surface water; and
- (b) the nature of such strata with respect to their strength, water-bearing characteristics, the presence or absence of geological faults and any other feature which may be relevant to prevent an inrush of water or other material which flows when wet.

10.3.2. (1) National laws or regulations should require, and the employer should prepare, a plan subject to the approval of the competent authority, to prevent an inrush of water or other material into the mine.

(2) A copy of the plan should be sent to the competent authority for approval before the plan is put into operation. The competent authority should have the duty of examining it and requiring

## **Inrushes of water, gas or other material**

any amendments necessary in the interests of safety before it is approved.

### **10.4. Precautions where salt deposits are present**

10.4.1. Before abandonment, boreholes should be filled so that no water can penetrate through them from the surface into the coal seam, even if they have not reached the coal seam.

10.4.2. In areas where salt deposits overlie coal seams that could be mined, the salt should not be worked by solution from boreholes.

10.4.3. If water has been encountered in any mine where hydrogen sulphide ( $H_2S$ ) has been detected, special precautions should be taken against poisonous gases when draining or otherwise dealing with such water.

## **11. Electricity**

Where national laws, regulations and standards do not contain prescription or contain ineffective or outdated prescription as to electricity, this chapter provides guidance. The provisions outlined in this chapter, which include some reference to a hazard identification, risk assessment and control process, should be used in conjunction with the proper application of such a process.

### **11.1. Hazard description**

11.1.1. The use of electricity and energized equipment in underground coalmines can result in injuries and death from electrical shock or arc burns. Given the confined space in underground mines, which are a dark, and at times a harsh environment, with several pieces of energized equipment and circuitry in close proximity to workers and with self-propelled equipment in motion, the potential for shock or electrocution exists.

11.1.2. Coalmines contain natural deposits of coal, coalmine dust and mine gases that are flammable and explosive. The introduction of electrical and energized equipment into coalmines creates the potential for igniting mine fires and explosions, which can cause numerous deaths and injuries from single events and devastate the mine.

### **11.2. Hazard control**

#### **11.2.1. General provisions**

11.2.1.1. National laws or regulations should establish standards regarding the use of electricity and electrical and energized equipment in underground coalmines which should:

- (a) specify the standards and testing requirements for enclosures that make electrical equipment (and all associated components, apparatuses, circuits, connection boxes and accessories) “flameproof” (“explosion protected” and “permissible”), and/or in compliance with zone classifications to assure that such equipment will not cause a fire or explosion;
- (b) prohibit any electrical equipment (including battery and diesel) or components, tools, pumps or lights from being used beyond the last open cross-cut of a coal heading/face or in a return air course, or any other location that is determined by the competent authorities, unless it has been certified and is maintained as “flameproof” or intrinsically safe by meeting recognized standards as an apparatus that will not ignite a fire or explosion;
- (c) require each employer to maintain a register of all equipment in use or intended to be used at the mine;
- (d) specify any restrictions on voltages that may be used in underground mines such as at coalfaces, and the protections and safeguards to be in place for various voltages transmitted into and used in the mine;
- (e) specify the training, qualifications and experience required of individuals who are to perform electrical work;
- (f) specify the intervals and methods for inspection of electrical equipment, with increased inspections of “flameproof” and intrinsically safe equipment;
- (g) establish standards for earthing (grounding) electrical equipment and components to the earth and the use of ground fault protection and ground (check) monitoring which would continuously monitor such grounding and automatically de-energize the equipment if a fault should occur in the grounding;

## **Safety and health in underground coalmines**

- (h) identify the loads to be carried on electrical circuits and the design and functioning of circuit breakers;
- (i) specify the size of electrical cables, conductors and wiring, the type of insulation protection to be used with different voltages being carried and the requirements for any splicing of cables;
- (j) specify the types of conductors that may be used and the conditions in which they may be used;
- (k) identify the specific electrical components and location requirements of the mine electrical map; and
- (l) establish rules for working on electrical equipment, including “troubleshooting” problems.

11.2.1.2. Electrical equipment should only be installed in any mine or part of a mine in strict accordance with the regulations in effect.

11.2.1.3. Where electricity is used at a mine, the employer should have the responsibility of:

- (a) appointing an electrical engineer;
- (b) providing an adequate number of competent electricians to fulfil the requirements of this chapter;
- (c) making financial provisions for the proper training of an adequate number of persons to fulfil the requirements of this chapter;
- (d) providing adequate training facilities for the persons engaged in fulfilling the requirements of this chapter; and
- (e) implementing the provisions of Chapter 11 (this chapter) and any other provisions specified by national laws, regulations or the competent authority.

11.2.1.4. (1) Small mines (as defined by national laws or regulations) which do not have sufficient resources to fulfil the require-

ments of this chapter should pool their resources with other mines, or make such appropriate arrangements as to be able to comply with the requirements.

(2) Notwithstanding the requirements of paragraph 11.2.1.4(1), any mine using electricity should employ a competent electrician.

11.2.1.5. (1) It should be the duty of the employer to ensure that the electrical engineer appointed prepares and implements an electrical plan with respect to the installation, re-installation and use of the electrical apparatus at the mine.

(2) This electrical plan should cover:

- (a) the examination and testing of all electrical equipment before it is energized after installation or re-installation, as the case may be;
- (b) the systematic examination and testing of all electrical apparatus at the mine to ensure proper maintenance thereof;
- (c) the intervals, which may differ for parts of apparatus, within which all electrical apparatus must be examined and tested;
- (d) the nature of the examination and testing to be carried out;
- (e) a system to ensure the safety of persons working on electrical apparatus or systems; and
- (f) the registration of installations and the recording of the results of examinations and testing.

11.2.1.6. Properly constructed switchgear for cutting off the entire supply of current to the mine should be provided at the surface of the mine, and should be connected directly with the main substation below ground.

11.2.1.7. During the time any conductor is live, a person authorized to operate the said switchgear should be available within reach thereof.

## **Safety and health in underground coalmines**

11.2.1.8. Efficient means, suitably placed, should be provided for cutting off all current from every electrical circuit in the mine as may be necessary to prevent danger. These should be included in the fire prevention and emergency response plan contained in Chapter 9.

11.2.1.9. No person, except a qualified engineer/electrician or a competent person acting under his/her supervision, should undertake any electrical work where technical knowledge or experience is required.

11.2.1.10. Only appropriately marked, approved or permitted electrical apparatus suitable for the purpose should be used.

11.2.1.11. A map showing the location of all electrical distribution infrastructure at the mine should be required at each mine by national laws or regulations and each employer should maintain such a map. The location and the electrical rating of all stationary electrical apparatus in connection with the mine electrical system, including permanent cables, switchgear, rectifying substations, transformers, permanent pumps, and trolley wires and trolley feeder wires, and settings of all direct-current circuit breakers protecting underground trolley circuits, should be shown on the mine map. Any changes made in a location, electrical rating, or setting should be promptly shown on the map when the change is made. Such a map should be available to the competent authority and to the miners in such a mine.

11.2.1.12. At places where electrical apparatus is installed, the following notices should be kept posted where they can be easily seen and read:

- (a) a notice prohibiting any unauthorized person from handling or interfering with apparatus;

- (b) a notice containing directions as to the procedure in case of fire;
- (c) a notice containing instructions on how to communicate with the person appointed to cut off the electric power on the surface of the mine; and
- (d) a notice containing directions as to the rescue and first aid of persons suffering from electric shock or burns.

### 11.3. Electrical systems

#### 11.3.1. Conductors and insulation

11.3.1.1. All electric conductors shall be sufficient in size, have adequate current-carrying capacity and be of such construction that a rise in temperature resulting from normal operation will not damage the insulating materials.

11.3.1.2. All parts of underground electrical systems should normally be kept efficiently insulated from earth, excluding frames of equipment and grounding conductors.

#### 11.3.2. Earthing (grounding) systems

11.3.2.1. Where any point of an underground system is earthed, it should be connected to an earthing system at the surface of the mine, unless national laws or regulations permit another equivalent earthing system.

11.3.2.2. All earthing conductors should be electrically continuous throughout and in efficient electrical connection with earth and with the apparatus that they are intended to earth.

11.3.2.3. Adequate electrical protection should be provided against earth faults.

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### 11.3.3. Overload and short-circuit protection

11.3.3.1. The current in all systems should be so controlled that when, in any circuit, the current exceeds a specified value, it is automatically cut off.

### 11.3.4. Transformers and switchgear

11.3.4.1. The places where transformers are installed should be adequately ventilated so that the heat generated by them is efficiently dissipated.

11.3.4.2. Oil-filled transformers should not be used.

11.3.4.3. Switchgear should be designed so that it cannot be closed accidentally by gravity, impact or any other cause.

11.3.4.4. Switchgear should be provided with no-volt or under-volt protection to avoid inadvertent or uncontrolled restarting of machines.

11.3.4.5. High-voltage switchgear should not contain oil or polychlorinated biphenyls (PCBs).

11.3.4.6. Where switchgear can be electrically charged from duplicate sources of supply, means should be provided to isolate the switches from both sources.

### 11.3.5. Flexible cables

11.3.5.1. Flexible cables used with hand-held, portable or transportable apparatus should be of the multi-core type and should comprise an earthing conductor of adequate cross-sectional area and conductance.

11.3.5.2. At every point where any flexible cable is joined to main cables, a switch should be provided to cut off the current from the flexible cable.

11.3.5.3. Cables to be installed in shafts should be of the appropriate type.

11.3.5.4. Shaft and slope cables, the conductors or coverings of which are capable of sustaining their own weight, should be secured at suitable intervals by adequate supports.

11.3.5.5. Relevant laws, regulations and standards should determine the specifications for the design, maintenance and use of flexible cables.

#### 11.4. Additional precautions against methane or coal-dust explosions

11.4.1. If the methane content of the general body of the air in any place or area exceeds a percentage to be determined by national laws or regulations, the current:

- (a) should be immediately cut off from all conductors and apparatus affected, except that which may be monitoring the mine atmosphere and is intrinsically safe;
- (b) should not be switched on again so long as the said percentage remains; and
- (c) should be reintroduced only under the direction of the official in charge of that part of the mine, after the official has deemed it safe to do so.

11.4.2. Unless national laws or regulations referred to in section 11.4.1 stipulate otherwise, electrical current in the affected area should be shut off when the level of methane reaches 1 per cent or more as described in section 21.9.

11.4.3. Flameproof apparatus should not be altered or changed in any way that would impair its efficiency and safety.

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### **11.5. Operating requirements**

11.5.1. The current should always be cut off from all conductors and apparatus which are not in use.

11.5.2. No unauthorized person should enter a substation or transformer room or interfere with the working of any apparatus connected therein.

11.5.3. No work should be done on any live conductor or live part of apparatus except for troubleshooting by qualified electricians as defined by national laws or regulations.

11.5.4. (1) When work is being done on apparatus or conductors, special care should be taken in accordance with national laws and regulations to ensure that they remain de-energized.

(2) A lock-out and tag-out programme should be in place. The person performing the electrical work should:

- (a) de-energize the power, place a tag alerting that the electrical system is being worked on and place a lock at the disconnect switch, with that same person holding the key to prevent unintentional energizing; and
- (b) before the equipment is energized the person with the key should determine work is complete and no one is at risk from the re-energizing or from any movement of equipment or devices that may be affected by restoring power.

### **11.6. Additional measures**

11.6.1. The competent authority may require additional measures regarding the use of electrical equipment in the interests of safety.

## **12. Machinery and plant (equipment)**

Where national laws, regulations and standards do not contain prescription or contain ineffective or outdated prescription as to machinery and plant (equipment), this chapter provides guidance. The provisions outlined in this chapter, which include some reference to a hazard identification, risk assessment and control process, should be used in conjunction with the proper application of such a process.

### **12.1. Hazard description**

12.1.1. The operation of machinery and plant can place workers at risk. Self-propelled equipment (plant) can cause crushing injuries when workers are struck by or caught between the equipment and other obstacles. Equipment that does not have proper braking or control systems can cause accidents. Machinery that is not properly designed or used can also result in injury. This is an increased hazard in the confined spaces of coalmines. A lack of fencing (guards) or inadequate fencing on machines can lead to accidents caused by entanglement, sheering, crushing, trapping or cutting.

### **12.2. Hazard control**

12.2.1. All machinery and plant used in connection with the working of the mine should be of good design, sound construction, suitable material, adequate strength, free from patent defect and properly maintained.

12.2.2. The employer should provide adequate training facilities and training of an adequate number of persons to effectively fulfil the requirements of this chapter.

## **Safety and health in underground coalmines**

12.2.3. Small mines (as defined by national laws or regulations) which do not have sufficient resources to fulfil the requirements of this chapter should pool their resources with other mines or make such other arrangements as to be able to comply properly with the requirements.

12.2.4. A qualified mechanical engineer should be in charge of the mechanical apparatus at every mine.

12.2.5. National laws or regulations should specify the qualifications and experience required of the mechanical engineer in charge and of the staff who operate under his/her direction.

12.2.6. No person except a qualified engineer/mechanic or a competent person acting under his/her supervision, should undertake any work on machinery and plant where technical knowledge or experience is required.

12.2.7. (1) It should be the duty of the employer of every mine to ensure that the competent engineer appointed prepares and implements a plan with respect to the mechanical apparatus at a mine.

(2) This plan should cover:

- (a) the systematic examination and testing of all mechanical apparatus at the mine to ensure proper maintenance thereof, including the nature of the examination and testing;
- (b) the intervals, which may differ from part to part of an apparatus, at which all mechanical apparatus should be examined and tested;
- (c) the examination and testing which should be carried out following repairs or reassembling of all mechanical apparatus;
- (d) the method and manner by which mechanical apparatus should be dismantled;

## **Machinery and plant (equipment)**

- (e) a system to ensure the safety of persons working on mechanical apparatus; and
- (f) the manner in which the records of examination and testing should be kept.

(3) The plan should be kept at the office of the mine, and the competent authority should request amendments where it appears necessary to secure the proper maintenance of the mechanical apparatus.

12.2.8. (1) The employer should have a standard operating procedure for checking each mobile plant used at the mine. This would include the frequency of examinations of the equipment which should be established by national laws or regulations.

(2) The procedure should include provision for the operator of the plant, as soon as practicable after taking control of it, to check that its brakes, steering, lights and any other safety features are functioning properly.

12.2.9. The employer should have in place underground transport rules which describe:

- (a) the conditions under which transport is to be used;
- (b) the ensuring of the safe operation of transport;
- (c) the minimum width and height for each length of roadway on which transport is to be used;
- (d) the measures to be taken to keep roadways clear of debris or other materials that may be impacted by transport;
- (e) the maximum loads (by reference to weight, dimensions, number or other criteria) that may be carried in or towed by transport;
- (f) the areas in which speed restrictions on transport apply;

## **Safety and health in underground coalmines**

- (g) the roadways (surface and underground) on which persons may be transported and for each length of roadway the loads that may be carried and the type of transport that may be used;
- (h) the conditions under which a person may work on or adjacent to a roadway to be used by transport;
- (i) the parking procedures for transport; and
- (j) the safe refuelling of transport.

12.2.10. A sufficient number of qualified persons for the proper performance of the duties required by this chapter should be appointed by the employer.

12.2.11. (1) All internal combustion engines used underground should be of a type approved by the relevant authority.

(2) The provisions of section 19.8 should apply.

### **12.3. Underground face equipment, and continuous mining and coal-cutting machines**

12.3.1. All self-propelled diesel-powered and electric face equipment, including shuttle cars, which are used in the active workings of each underground coalmine should be equipped with substantially constructed canopies or cabs, located and installed in such a manner that when the operator is at the operating controls of such equipment he/she shall be protected from falls of roof, face or side, or from side and face rolls.

12.3.2. All electric face equipment which is taken into or used in by the last open cross-cut of any coalmine should be flameproof (permissible) as specified in paragraph 11.2.1(a) and (b).

12.3.3. Methane monitors should be installed on all face roof-bolting machines and cutting machines, continuous miners, longwall face equipment, loading machines and other mechanized

## **Machinery and plant (equipment)**

equipment used to extract or load coal within the working place as specified in section 21.11.

12.3.4. Roof bolters, continuous mining machines and coal-loading equipment should be equipped with lighting to illuminate the workplace as described in section 22.3.

12.3.5. All face equipment used to cut coal or drill holes for roof supports should be equipped with engineering controls such as water sprays, dust collectors and air-scrubber systems to control the respirable coalmine dust as described in section 8.3.

12.3.6. Where remote control devices are used in underground coalmines and on coalfaces to operate continuous mining machines or other such equipment, the employer should:

- (a) test the remote control devices to ensure they are all on separate frequencies and will not accidentally cause a machine not being intentionally operated to activate or move;
- (b) properly train all operators in the use of the remote control devices; and
- (c) design a mining plan for the use of remote control mining equipment which includes the safe locations for the machine operator and any other workers in the area to prevent crushing accidents while the machine is in movement, and to prevent workers from being exposed to respirable dust and noise hazards.

12.3.7. To avoid crushing injuries where remote control mining face equipment is used, employers should evaluate the use of proximity protection, such as a system that can be installed on a continuous mining machine, with devices attached to workers and programmed to send warning and machine shutdown commands when a miner enters a hazardous zone.

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### **12.4. Guarding (fencing) of machinery**

12.4.1. All flywheels, gears, belts, rotating shafts and other moving parts of machinery and plant at a mine, which may cause injury, should be kept securely guarded.

12.4.2. Fixed guards should be used wherever necessary, and properly fastened in place with appropriate fasteners including, but not limited to, screws or nuts and bolts which need tools to remove them

12.4.3. If workers need regular access to parts of the machine and a fixed guard is not possible, an interlocked guard should be used to ensure that the machine cannot start before the guard is closed and will stop the machine if the guard is opened. If access is required to parts that are guarded, the machinery should be shut down.

12.4.4. It should be the duty of supervisory officials and other authorized persons to keep all guarding properly maintained, in good condition and in the correct position.

12.4.5. If persons passing or handling machinery at points distant from the driving engine or motor can be endangered thereby, effective signals or other means should be installed to enable such persons to stop the engine or motor, and to ensure that it is not accidentally or inadvertently restarted.

### **12.5. Boiler and steam plant**

12.5.1. No steam boiler or other steam-raising plant should be installed underground.

12.5.2. Paragraph 12.5.1 should not apply to approved devices for vulcanizing or other purposes, which are approved by, or conform to the specifications set out by, the competent authority.

## **Machinery and plant (equipment)**

12.5.3. Every boiler installed on the surface of the mine, whether separate or part of a range, should be provided with:

- (a) a suitable safety valve;
- (b) a suitable steam gauge and a suitable water gauge to show respectively the pressure of steam and the height of the water in that boiler; and
- (c) an effective guard or other protection for the gauges provided on each boiler.

12.5.4. The maximum pressure at which steam should be generated, and the blow-off pressure, should be marked on each steam gauge, and each boiler attendant should be made familiar with this arrangement.

12.5.5. Boiler attendants should receive adequate instruction and training for the duties they have to perform.

12.5.6. The cleaning and maintenance of every steam boiler should be specified in the plan required by paragraph 12.2.7.

12.5.7. If steam boilers are used in mines, they should be of a type approved by, or conform to specifications set out by, the competent authority.

## **12.6. Compressed-air equipment**

12.6.1. Any compressor that compresses air, used underground in the mine, should be so designed, constructed, operated and maintained that:

- (a) air entering the compressor is as dry, clean and cool as practicable;
- (b) the maximum temperature of the air in the compressor is at least 30°C (86°F) below the flashpoint of the compressor lubricating oil;

## **Safety and health in underground coalmines**

- (c) the compressor is stopped either automatically or by the engineman, who should be in constant attendance while in operation, when the air temperature is too high or there is any interruption in the flow of fluid used in the compressor cooling system; and
- (d) the compressed air flowing in the pipe range to the top of the shaft is as dry and cool as practicable.

12.6.2. Compressors installed underground should:

- (a) be enclosed in a non-combustible structure, with intake air passing over it ventilated directly into the mine return air course;
- (b) be equipped with heat and carbon monoxide monitors that would signal an alarm and shut down the compressor in case of overheating or fire; and
- (c) be equipped with an automatic fire suppression device.

12.6.3. Only high-quality mineral oil or suitable synthetic oil, having a flashpoint to be specified by the competent authority, should be used for lubricating the compressor.

12.6.4. Unless the lubricating oil is certified by the manufacturer, to ensure that the requirements of paragraph 12.6.3 are met, tests should be made of the flashpoint of:

- (a) all fresh supplies of oil; and
- (b) the oil in the compressor, as often as is necessary.

12.6.5. The employer's plan of maintenance required by paragraph 12.2.7 should cover all aspects of compressed-air equipment.

12.6.6. (1) All receivers containing compressed air for use underground should comply with the requirements of the competent authority.

## **Machinery and plant (equipment)**

(2) They should be kept clean and free from carbonized oil or other material liable to ignition.

(3) They should be opened and examined at intervals not exceeding three months.

### **12.7. Cranes and lifting gear**

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

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

12.7.3. (1) No person should load any crane, grab or winch in excess of the safe working load except for the purpose of a test.

(2) This test should be carried out by an authorized person in an approved manner.

12.7.4. (1) Only equipment capable of supporting the effective load should be used.

(2) It should be the duty of the employer to ensure that equipment made available is appropriately and clearly marked.

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

## **Safety and health in underground coalmines**

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

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

12.7.8. All cranes or hoists with a boom that is movable in the vertical plane should:

- (a) have a device that can be clearly read by the operator, to indicate the boom angle if the rated capacity is affected; and
- (b) should be fitted with an automatic load indicator showing the safe working load.

12.7.9. 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, a competent person or authorized organization.

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

12.7.11. 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.

12.7.12. Effective audible and visual communication devices 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.

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12.7.13. 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.

12.7.14. 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.

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

12.7.16. 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.

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

12.7.18. The operator of a crane or hoist should perform a check at the start of each shift and test the limit switch, and a record of the check should be kept.

12.7.19. Transport routes for cranes should be clear of obstructions. Transport routes for wheeled or tracked cranes should be level. If irregular surfaces are inherent in the layout of the plant, the equipment should be designed to cope with this.

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

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

12.7.22. Training should be given for crane operators to ensure proper and safe operation of the crane and rigging loads.

## **13. Explosives and shot-firing**

Where national laws, regulations and standards do not contain prescription or contain ineffective or outdated prescription as to explosives and shot-firing, this chapter provides guidance. The provisions outlined in this chapter, which include some reference to a hazard identification, risk assessment and control process, should be used in conjunction with the proper application of such a process.

### **13.1. Hazard description**

13.1.1. Explosives used in any environment can be dangerous; however, explosives used in coalmines introduce hazards beyond those normally associated with explosives. The travel ways and workplaces in underground coalmines are confined spaces resulting in great intensity in the forces that are released when explosives detonate. Since coalmines contain natural fuels which include coal, coal dust and flammable and explosive mine gases, detonated explosives can ignite those fuels and cause mine fires and/or explosions that can place a large number of persons at risk from death or serious injury. When explosives are detonated they release noxious and poisonous gases into the mine air that can cause illness or death. Explosives are by nature dangerous to handle and transport. If they prematurely detonate while being transported or while being loaded into drill holes, the consequences can be deadly.

### **13.2. Hazard control**

13.2.1. National laws or regulations should establish standards for the general use of explosives which should:

- (a) specify the requirements regarding the transportation, storage, loading and use of explosives, detonators and blasting devices;

## **Explosives and shot-firing**

- (b) require that only explosives, blasting caps and devices, and detonating devices that are approved by the competent authority can be taken into or used in a coalmine;
- (c) require that on the surface of a mine, all explosives and detonators should be stored in a magazine constructed and situated in such a way as to ensure their security and safety;
- (d) limit the quantity of explosive issued to any one person;
- (e) limit the total quantity issued to the requirements of the shift with only a 48-hour supply of explosives permitted to be stored underground, and in specially designed storage facilities;
- (f) specify procedures for the conveyance of explosives in trolley locomotive haulages;
- (g) specify the number of holes that may be shot at one time and the delay time of detonators to be used;
- (h) prohibit the storage of explosives and detonators in the same facility;
- (i) specify the procedures for handling misfires; and
- (j) incorporate all of the appropriate safety rules contained in this chapter.

13.2.2. The delivery, conveyance, storage, issue and return of explosives should be handled by specially trained persons authorized by the employer.

13.2.3. The possession and use of explosives and detonators by persons other than those authorized by the employer should be prohibited.

13.2.4. (1) Frozen or deteriorated explosives, including explosives that show abnormal appearance and those that misfired, should not be taken into the mine.

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(2) If found underground, such explosives should be brought to the surface.

(3) On the surface, frozen explosives should be thawed with due precautions, and deteriorated explosives should be destroyed under the supervision of a competent person.

13.2.5. The competent authority should issue rules regarding:

- (a) the classification of explosives for safety purposes;
- (b) the rules to be complied with by explosives manufacturers as regards cartridging;
- (c) the particulars to be marked on cartridges; and
- (d) the substances and appliances designed to produce a similar effect to that of explosives.

### **13.3. Conveyance of explosives and detonators to the magazine**

13.3.1. When delivered to the mine, explosives and detonators should be immediately conveyed in a safe manner to an explosive store under the supervision of an authorized person.

13.3.2. Detonators should not be conveyed together with other explosives in the same container.

13.3.3. (1) In any mine where large quantities of explosives are transported and stored below ground, it should be the duty of the employer to prepare a plan which deals with the handling, transport and storage of such explosives.

(2) This plan should include provisions concerning:

- (a) the location, construction, ventilation and marking of each underground reserve station and the names and titles of persons who have custody of the keys thereof;

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- (b) the design and construction of the special carriage for the explosives;
- (c) the supervision of and the precautions to be taken during the transit of the carriage;
- (d) the supervision of the explosives held in the underground reserve station;
- (e) the manner in which quantities of explosives are taken to any working face;
- (f) the maximum quantity of explosives to be stored in the underground reserve station at one time;
- (g) the control of the issue of explosives from the underground reserve station, and the return of such explosives;
- (h) the duties of the persons in charge of the underground reserve station in ensuring security and safety; and
- (i) the precautions to be taken in case of fire or explosion.

### **13.4. Issue, return and recording of explosives and detonators**

13.4.1. Explosives and detonators should be issued in the place and in the manner designated by the employer.

13.4.2. Each type of explosive should, as far as possible, be issued in the same chronological order in which it was delivered to the mine.

13.4.3. Explosives should be issued only to persons authorized to receive them, and detonators should be issued only to persons authorized to fire shots.

13.4.4. Except where permitted under paragraph 13.4.3, all such authorized persons should, at the end of the shift, return all unused explosive to the place of issue and, except where an automatic

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receiving device is in operation at the place of issue, personally hand the explosives over to the person responsible for collecting them.

13.4.5. Admittance to explosives storage facilities of any person not authorized by the employer should be prohibited.

13.4.6. For sinking shafts and for driving surface or other drifts, and except where national laws or regulations or the competent authority permit otherwise:

- (a) the explosives issued should be carried only by authorized persons and only in adequate, closed canisters provided by the employer and approved by the competent authority;
- (b) the maximum quantity of explosive to be placed in any one canister should be specified by national laws or regulations;
- (c) explosives canisters should be equipped with locks, and each canister containing explosives should be kept locked until the explosive is required for use or for examination;
- (d) detonator cases should be equipped with a lock and constructed of substantial, non-conducting material in such a way that, when they are closed, it should be impossible for any detonator or the leads of any detonator contained in the case to touch any metal part exposed outside the case;
- (e) delay detonators should be kept in a separate detonator case, and should not be placed in a case containing an instantaneous detonator;
- (f) each delay detonator placed in a case should be clearly marked by a number which indicates the period of delay; and
- (g) national laws or regulations should specify the maximum period of delay for detonators of that type.

13.4.7. Each person to whom a detonator case has been issued should:

## Explosives and shot-firing

- (a) retain the key of the case in his or her possession during the time of the shift;
- (b) ensure that only detonators and a check sheet are kept in the case;
- (c) keep the detonator case separate from any canister containing explosives; and
- (d) keep the case on his or her person or, if this is not practicable, keep the case in a securely locked receptacle which does not contain any explosives.

13.4.8. Except where permitted for sinking shafts, or driving surface or other drifts, no shot-firer should remove a detonator from the case unless it is required immediately for charging a shot hole.

13.4.9. (1) A register should be kept for each explosives storage facility, and should contain particulars, including the names or the identification numbers of the persons concerned with the delivery, issue and return of explosives.

(2) The delivery, issue and return of explosives should be immediately entered in the register.

(3) The return of any unused explosive deposited in the automatic devices referred to in paragraph 13.4.4 should be recorded before the next distribution begins.

(4) The register should be balanced daily, compared with stock, and signed by the responsible person in charge of the magazine.

13.4.10. If any explosive is missing, the employer should be immediately informed.

13.4.11. No person should take away any explosive from a mine.

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13.4.12. The requirements of paragraphs 13.4.9 to 13.4.11 should also apply to detonators.

### **13.5. Keeping of explosives during the shift**

13.5.1. Shot-firers who are appointed for a number of workplaces, and who carry their own explosives, should keep the reserve of explosives in a special chest that should be kept securely locked.

13.5.2. Tools should not be placed in the aforementioned special chest.

13.5.3. Where permitted by the competent authority, explosives in the care of a shot-firer at the end of a shift may be handed over to an authorized shot-firer on the oncoming shift, together with the key to the explosives chest, providing the exchange of explosives is noted in detail in the register required by virtue of paragraph 13.4.9.

### **13.6. General provisions for shot-firing**

13.6.1. National laws or regulations should specify the restrictions governing shot-firing in coalmines.

13.6.2. (1) National laws or regulations should specify the training, qualifications and experience of shot-firers in coalmines.

(2) No one but such persons should be authorized by the employer to fire shots, except trainee shot-firers under instruction.

13.6.3. (1) Each shot-firer should keep a register of the shots fired.

(2) The register should be balanced and signed by the shot-firer at the end of each shift.

### 13.7. Equipment of a shot-firer

13.7.1. (1) It should be the duty of the employer to provide shot-firers with all the equipment they require for the proper execution of their duties.

(2) Each shot-firer should be provided with:

- (a) a tool made entirely of wood for charging and stemming shot holes;
- (b) a scraper suitable for cleaning shot holes;
- (c) an approved shot-firing cable suitable for single or multi-shot-firing as the case may be;
- (d) an approved shot-firing apparatus for single or multi-shots as the case may be; and
- (e) the removable handle of the shot-firing apparatus which should be kept in the possession of the shot-firer throughout the shift of duty.

### 13.8. Charging, tamping and firing

13.8.1. No person should begin to charge a shot hole unless it has been thoroughly cleaned.

13.8.2. No person should charge a shot until the shot-firer is satisfied that the shot hole is properly drilled, placed and safe for firing.

13.8.3. Any persons charging a shot hole should, to the best of their judgement, ensure that it is neither undercharged nor overcharged, having considered the task to be performed.

13.8.4. No shot hole should be charged with a weight of explosive which exceeds the maximum, which should be specified by the competent authority.

## **Safety and health in underground coalmines**

13.8.5. Tamping should consist of suitable non-flammable material.

13.8.6. Except where the infusion method is used, each shot hole should be stemmed with sufficient material to prevent a blown-out shot, and to ensure efficient results.

13.8.7. Supervisory officials should see that supplies of tamping material are available near the workplace where firing is being done.

13.8.8. The charging and tamping should be done by the shot-firer or under his or her personal supervision.

13.8.9. Explosive cartridges should be used only in the form in which they are delivered.

13.8.10. Explosive cartridges should not be forced into a shot hole.

13.8.11. Shot holes should not be charged until immediately before firing.

13.8.12. Explosive cartridges should not be fitted with detonators or fuses until immediately before use, except where otherwise permitted in section 17.25 for sinking shafts or for surface drifts or other cross-measure drifts.

13.8.13. When more than four shots are to be fired simultaneously in any one place, they should be fired electrically.

13.8.14. The shot-firer himself/herself should connect the shots together to the shot-firing lines and fire them.

13.8.15. Holes drilled in rock should be drilled wet, or dust-collecting apparatus approved by the competent authority should be used.

### 13.9. Water-infusion shot-firing

13.9.1. No shot should be fired by the water infusion method unless the explosives and detonators are approved for this purpose by the competent authority.

13.9.2. The shot-firer should make sure that the shot hole is filled with water before the shot is fired.

13.9.3. The infusion apparatus should be so constructed that it holds secure in the shot hole and is not ejected by the shot.

### 13.10. Protection against flying fragments

13.10.1. (1) Before connecting the firing line to the exploder, the shot-firer should determine the zone of danger and post guards.

(2) Where such guards are not available, fences marked with suitable notices giving warning of danger should be erected.

13.10.2. (1) The shot-firer should, before firing the shot, ensure that all persons in the vicinity have taken adequate cover.

(2) The shot-firer should be the last person to leave the workplace, and should take proper shelter.

13.10.3. If guards have been posted or fences erected, they should not be withdrawn or removed until the shot-firer has authorized access to the workplace.

13.10.4. If two workings approach each other and one of them is likely to be broken into by a shot fired in the other, the supervisory official should stop work in the latter working, withdraw the persons engaged therein in good time before the shot is fired, and fence it off.

13.10.5. Where the workings offer insufficient protection against flying fragments, all persons should be moved to a safe location where adequate shelter or other protection is provided.

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### **13.11. Procedure after shot-firing**

13.11.1. The shot-firer should:

- (a) not allow the workplace to be re-entered after firing until the area is properly ventilated and fumes have sufficiently dispersed;
- (b) ascertain by a personal examination that it is safe for normal work to be resumed; and
- (c) where the place is not safe, take the necessary action to make it safe before normal working is resumed.

13.11.2. (1) Where a round of shots has been fired the shot-firer should:

- (a) wait until all fumes and noxious gases have been dispersed before making the examination; and
- (b) examine for sockets in the face and for any remnant of explosive in such sockets.

(2) If the shot-firer suspects that there may be a misfire or a charge not fully exploded, they should carefully inspect the material brought down by the shot and, if they do not recover the explosive and the detonator, the material should be loaded and transported separately for further examination.

13.11.3. It should be prohibited to scrape out or drill out shots wholly or partly, or to drill further into sockets.

### **13.12. Misfired shots**

13.12.1. (1) It should be the duty of the employer of every mine where shot-firing takes place to draw up a plan which instructs all shot-firers in the detailed procedure to be followed in the event of a misfired shot.

(2) The procedures should cover single shot-firing and shot-firing in rounds where this is practised.

### **13.13. Miscellaneous provisions for shot-firing**

13.13.1. (1) Electrical shot-firing apparatus should be regularly inspected, cleaned and overhauled at intervals which should be specified by national laws or regulations.

(2) Such apparatus should be maintained in good condition.

13.13.2. Electrical shot-firing apparatus should be used only by an authorized shot-firer.

13.13.3. The shot-firer should couple the machine to the shot-firing lines only at the moment of firing the shot.

13.13.4. No more shots should be charged than can safely be fired simultaneously by the shot-firing apparatus used.

13.13.5. (1) For shot-firing lines, only insulated conductors should be used.

(2) Their minimum length should be specified and related to the duty to be performed.

13.13.6. Precautions should be taken to prevent shot-firing lines from coming into contact with other electrical conductors.

13.13.7. Where firing from the mains is permitted by national laws or regulations:

- (a) the connection of the firing line to the power line should be effected only through a switch that is under lock and key, and cuts off the current on all poles;
- (b) a second disconnecting device, also under lock and key, should be inserted between the switch and the firing line; and
- (c) shot-firing cable should not be laid in the same conduits as wires for cables for other purposes.

## **Safety and health in underground coalmines**

13.13.8. When several shots have to be fired at the same time:

- (a) care should be taken that all connections are properly made;
- (b) unless otherwise directed, all shots to be fired should be connected in series in mines that have the potential for sudden outbursts of gas; and
- (c) the main conductor to the machine or the mains should be connected last and should be of sufficient length to provide safe detonation.

### **13.14. Special provisions for shot-firing in stone drifts**

13.14.1. If approved by the competent authority, it should be lawful for a shot-firer engaged in a cross-measure drift, to prime the cartridges to be used in that round at a place at least 45 metres (approximately 150 feet) from the face, provided that:

- (a) the place in question has been selected by the employer;
- (b) the shot-firer has been appointed by the employer to prime cartridges at that place;
- (c) immediately after the shot-firer has removed a detonator from its case to prime a cartridge, the shot-firer short-circuits the detonator leads;
- (d) the shot-firer is provided with a specially constructed box divided into separate compartments for primed cartridges;
- (e) immediately after each cartridge has been primed, the shot-firer places it in the specially constructed box which is kept securely locked;
- (f) only primed cartridges are placed in or taken out of the box; and
- (g) detonators of different delay are not placed in the same compartment of the box.

13.14.2. Priming of cartridges should not begin until the shot-firer has established that the shot holes can be charged immediately after completing the priming.

### 13.15. Additional precautions during shot-firing

13.15.1. (1) It should be the duty of the employer to fix the maximum number of shots to be fired per heading or face, hour and shift by each shot-firer.

(2) The competent authority may direct amendments to be made in the interests of safety.

13.15.2. At any place where methane is indicated by the lowered flame of the safety lamp, or where an approved methane detector shows a percentage in excess of the level specified by national laws or regulations, shot-firing should be prohibited.

13.15.3. The aforementioned prohibition should not be lifted until the senior official on duty at the mine has examined the place and satisfied himself/herself that it is safe to resume shot-firing.

13.15.4. Where delay-action detonators are used in coalmines, national laws or regulations should specify the maximum period of delay between the firing of the first and last shot in the round.

13.15.5. (1) National laws or regulations should also specify the conditions under which delay detonators are used in stone drifts approaching a coal seam or waste area.

(2) Shot-firing with delay detonators should be carried out according to a specific plan approved by the employer.

13.15.6. (1) The shot-firer should test the air for methane within a radius to be specified in national laws or regulations, immediately before loading and charging each shot and before firing.

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(2) In particular, the air in cavities, breaks and other accessible places where methane might accumulate within the radius should be tested.

(3) For the purpose of this paragraph, methane is considered to be present when it is indicated by the lowered flame of the safety lamp, or when approved methane detectors show a percentage in excess of the level specified by national laws or regulations.

13.15.7. The hole should not be charged if:

- (a) any break is found in the hole and methane is found to be issuing from it; or
- (b) methane is found in the general body of the air.

13.15.8. If, after charging, methane is found within the described radius, the charge should not be fired until the methane has been cleared.

13.15.9. Before rounds of shots are fired the shot-firer should:

- (a) carry out an examination for general safety, and test for the presence of flammable gas over the whole area to be covered by shot-firing;
- (b) immediately before the first shot hole of any round is charged, test for gas:
  - (i) in every accessible place within 10 metres (approximately 33 feet) of each of the two shot holes which are furthest apart in the round;
  - (ii) at the mouth of each shot hole in the round; and
  - (iii) along the edge of any waste in the vicinity; and
- (c) immediately before firing the round, test for gas in the vicinity of each shot hole and along the edge of any waste opposite.

13.15.10. The firing area should be adequately protected by stone dusting or watering before charging the shots when detonat-

## **Explosives and shot-firing**

ing explosives in coal seams with the potential to produce dangerous dust.

13.15.11. In mines with the potential of sudden outbursts of gas, shot-firing should be subject to special regulations issued by the competent authority.

13.15.12. When a mine is closed down or when operations are suspended with the intention of closure, no explosives should be left underground.

## **14. Surface buildings, other surface structures and surface roads**

Where national laws, regulations and standards do not contain prescription or contain ineffective or outdated prescription as to surface buildings, other surface structures and surface roads, this chapter provides guidance. The provisions outlined in this chapter, which include some reference to a hazard identification, risk assessment and control process, should be used in conjunction with the proper application of such a process.

### **14.1. Hazard description**

14.1.1. Surface buildings and structures at coalmines such as plants that prepare and process coal, thermal drying facilities, belt conveyor structures, coal stockpiles and tunnels under them, refuse piles, impoundments and dams can pose hazards to workers if not properly constructed and maintained. If not properly constructed, maintained and managed, traffic ways can similarly create hazards.

### **14.2. Hazard control**

#### **14.2.1. Safety of buildings and related structures**

14.2.1.1. All buildings and structures on the surface of the mine should be of sound construction, kept in safe condition, maintained in good repair and, wherever possible, be constructed of fire-resistant material.

14.2.1.2. Each active working area and surface installation should be examined for hazardous conditions by a competent person at least once during each working shift, or more often if necessary for safety.

## **Surface buildings, other surface structures and surface roads**

14.2.1.3. Safe means of access to every place or building where any person has to pass or work should be provided and maintained.

14.2.1.4. (1) Openings in surface installations through which persons or material may fall should be protected by railings, barriers, covers or other protective devices.

(2) Where any person could fall a distance of 2 metres (approximately 6.5 feet) or any other distance specified in national laws or regulations, secure footholds, handholds and fences should be provided as are necessary to prevent danger.

(3) Where these provisions are not practicable, properly designed safety harnesses should be used.

14.2.1.5. Thermal dryer systems should be separated from all other working areas and be examined for fires and coal-dust accumulations if the dryers are not restarted promptly after a shutdown.

14.2.1.6. Mobile equipment should not operate on coal stockpiles where voids may exist without safety equipment, which would prevent equipment cabs from collapsing and operators from suffocating if the equipment were to slide into a void; equipment should not be operated near potential voids.

14.2.1.7. Tunnels located below stockpiles, surge piles and coal storage silos should be ventilated so as to maintain concentrations of methane below 1 per cent.

14.2.1.8. Belt conveyors in locations where fire would create a hazard to personnel should be provided with switches to stop the drive pulley automatically in the event of excessive slippage.

14.2.1.9. Firefighting facilities and equipment should be provided commensurate with the potential fire hazards at each structure, enclosure and other facility (including custom coal preparation) at the mine, and the employees at such facilities shall be

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instructed and trained annually in the use of such firefighting facilities and equipment.

### **14.2.2. Surface roads**

14.2.2.1. (1) Traffic rules, signals and warning signs should be standardized at each mine and posted.

(2) It should be the duty of the manager of a mine to make and post in a prominent place transport rules, as specified in Chapter 19, which control the flow and movement of vehicular traffic on the surface of the mine, so as to secure the safety of all persons employed there.

(3) As far as possible, the signs used in the control of traffic should be the same as those used on public roads.

14.2.2.2. Only authorized persons should be permitted on haulage roads and at loading or dumping locations.

14.2.2.3. Vehicles should follow at a safe distance; passing should be limited to areas of adequate clearance and visibility.

14.2.2.4. Lights, flares or other warning devices should be posted when parked equipment creates a hazard to vehicular traffic.

14.2.2.5. Mobile equipment should be provided with audible warning devices. Lights should be provided on both ends when required.

14.2.2.6. Berms or guards should be provided on the outer bank of elevated roadways.

14.2.2.7. Equipment and vehicle operating speeds should be prudent and consistent with roadway, grades, clearance, visibility and traffic conditions and the type of equipment used.

14.2.2.8. Where side or overhead clearances on any haulage road or at any loading or dumping location at the mine are hazard-

## **Surface buildings, other surface structures and surface roads**

ous to workers, such areas should be conspicuously marked and warning devices should be installed when necessary to ensure safety.

14.2.2.9. High-voltage power lines located above traffic ways, haulage ways and railroad tracks should be installed to provide the minimum vertical clearance as specified by the competent authority but should not be installed less than 4.5 metres (approximately 15 feet) above ground.

### **14.2.3. Mine refuse**

14.2.3.1. (1) It should be the duty of the employer, where it is proposed to tip (dump) mine refuse, to determine that the proposed site is suitable and safe in all respects.

(2) In assessing safety and suitability, consideration should be given to safeguarding the safety of the civilian population during normal tipping operations and also in the event of a refuse slide.

14.2.3.2. (1) Plans and sections of the proposed refuse-tipping operations should be prepared by a qualified and competent civil engineer and should include the following:

- (a) provisions for a system of drainage for the refuse;
  - (b) the maintenance of the drainage system;
  - (c) the manner in which tipping operations are to be carried out in order to avoid any dangerous occurrence and prevent danger to persons;
  - (d) the nature and frequency of tip inspections and the reporting thereon; and
  - (e) actions to be taken in the event of a defect or other dangerous condition.
- (2) A geological map of the area should also be provided.

## **Safety and health in underground coalmines**

(3) The plans should be submitted to the competent authority for review and approval with amendments made as necessary.

(4) The plans, sections and geological map should be kept at the office of the mine and be available for review by interested parties.

14.2.3.3. It should be the duty of the manager to appoint competent persons who will supervise tipping operations, inspect and report upon the safety of the tip and appoint a qualified and competent civil engineer to be responsible for the maintenance and security of the refuse pile.

14.2.3.4. A record of the refuse tipped should be kept by the person responsible for the safety of the tip.

14.2.3.5. Refuse piles should be located in areas which are a safe distance from all underground mine airshafts, preparation plants, tipples or other surface installations; such piles should not be located over abandoned openings.

14.2.3.6. Foundations for new refuse piles and additions to existing refuse piles should be cleared of all vegetation and undesirable material that, according to current, prudent engineering practices, would adversely affect the stability of the refuse pile.

14.2.3.7. Where new refuse piles are constructed over exposed coal beds, the exposed coal should be covered with clay or other inert material as the piles are constructed and a fireproof barrier of clay or inert material should be constructed between old and new refuse piles.

14.2.3.8. Refuse deposited on a pile should be spread in layers and compacted in such a manner as to minimize the flow of air through the pile; no extraneous combustible material should be deposited on refuse piles.

14.2.3.9. Refuse should not be deposited on a burning pile except for the purpose of controlling or extinguishing a fire, and clay

## **Surface buildings, other surface structures and surface roads**

or other sealants should be used to seal the surface of any refuse pile in which a spontaneous ignition has occurred.

14.2.3.10. Surface seals should be kept intact and protected from erosion by drainage facilities.

14.2.3.11. Refuse piles should be constructed in such a manner as to prevent accidental sliding and shifting of materials and not be constructed so as to impede drainage or impound water.

### 14.2.4. Impoundments (dams and lagoons)

14.2.4.1. The provisions of paragraphs 14.2.3.1 and 14.2.3.2 should apply to impoundments in the same way as they apply to refuse.

14.2.4.2. Plans prepared by the employer which should be reviewed, approved or amended by the competent authority for the design, construction and maintenance of structures which impound water, sediment or slurry should be required if such an existing or proposed impounding structure can:

- (a) impound water, sediment or slurry to an elevation of 1.5 metres (approximately 5 feet) or more above the upstream toe of the structure and can have a storage volume of 24,500 cubic metres (20 acre-feet) or more; or
- (b) impound water, sediment or slurry to an elevation of 6 metres (approximately 20 feet) or more above the upstream toe of the structure; or
- (c) as determined by the competent authority, present a hazard.

14.2.4.3. Plans for the design and construction of all new water, sediment or slurry impoundments and impounding structures listed in paragraph 14.2.4.2 should be submitted to, amended if necessary, and approved by, the competent authority prior to the beginning of any work associated with the construction of the impounding structure.

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14.2.4.4. The plans should include:

- (a) provisions for construction surveillance, maintenance, and repair of the impounding structure;
- (b) the minimum factor of safety range for the slope stability of the impounding structure;
- (c) locations of surface and underground coalmine workings including the depth and extent of such workings within the area 150 metres (approximately 500 feet) around the perimeter;
- (d) the runoff attributable to the probable maximum precipitation of six-hour duration;
- (e) the amount of runoff attributable to storms for which the structure is designed;
- (f) a certification or finding that the design of the impounding structure is in accordance with prudent engineering practices for the maximum volume of water, sediment or slurry which can be impounded and for the passage of runoff from the designed storm which exceeds the capacity of the impoundment;
- (g) a description of the spillway and diversion design features; and
- (h) any other information required by the competent authority.

14.2.4.5. The employer should appoint a competent person to be responsible for the maintenance and security of each impoundment.

### **14.2.5. Reporting of dangerous occurrences**

14.2.5.1. National laws or regulations should specify what constitutes a dangerous occurrence in relation to refuse piles and impoundments.

14.2.5.2. Such dangerous occurrences should be reported forthwith to the competent authority, which should take appropriate action.

## **15. Surveyors and plans**

Where national laws, regulations and standards do not contain prescription or contain ineffective or outdated prescription as to surveyors and plans, this chapter provides guidance. The provisions outlined in this chapter should be used in conjunction with the proper application of a hazard identification, risk assessment and control process.

### **15.1. Appointment of a certified mining engineer/surveyor**

15.1.1. No mine should be worked unless there is a certified mining engineer/surveyor for the mine appointed by the employer. The certified mining engineer/surveyor should be qualified as specified by national laws or regulations and the employer should notify the appointment to the competent authority.

### **15.2. Duties of the certified mining engineer/surveyor**

15.2.1. It should be the duty of the certified mining engineer/surveyor of the mine:

- (a) to prepare or supervise the preparation of all plans, drawings and sections of the mine which are required by national laws or regulations;
- (b) to establish the accuracy of any plans, drawings or sections which have not been prepared by him/her; and
- (c) to ensure that all working papers, calculations or other notes which were used in the preparation of any plans, drawings and sections are signed and dated, properly filed and preserved.

### **15.3. Plans: General**

15.3.1. (1) National laws or regulations should provide that the employer in charge of the mine ensures that appropriate plans

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of workings are prepared before the start of operation and, in the event of any significant modification, that such plans are brought up to date periodically and kept available at the mine site.

(2) Unless national laws or regulations stipulate otherwise, each plan required to be maintained for mining health and safety in this code of practice should be reviewed at least every six months; changes such as mining advancement should be updated each day.

15.3.2. Every mine should keep accurate plans showing separately for each seam worked, particulars of all the workings, as well as a surface plan showing, as far as possible, the boundaries of the mine and the position of the workings with regard to the surface, and such other information as may be specified by national laws or regulations. See additional provisions in section 10.2.

15.3.3. All mine plans should be kept up to date as specified in national laws or regulations.

15.3.4. At every mine, there should be posted on the surface, where it can be clearly seen by the workers, a plan or plans of the mine showing the main roads, the means of egress from each part of the mine to the surface – including the escape routes – and the position of all telephones.

15.3.5. Every mine should keep a geological map of the district in which the mine is situated, and this map should contain such information as is prescribed by national laws or regulations.

15.3.6. Employers should take all necessary measures to ensure that the mine is designed, constructed and provided with electrical, mechanical and other equipment, including a communication system, to provide conditions for safe operation and a healthy environment.

15.3.7. A map showing the location of all electrical distribution infrastructure at the mine should be required at each mine by

national laws or regulations and each employer should maintain such a map. The location and the electrical rating of all stationary electrical apparatus in connection with the mine electrical system, including permanent cables, switchgear, rectifying substations, transformers, permanent pumps, and trolley wires and trolley feeder wires, and settings of all direct-current circuit breakers protecting underground trolley circuits, should be shown on the mine map. Any changes made in a location, electrical rating, or setting should be promptly shown on the map when the change is made. Such a map should be available to the competent authority and to the miners in such a mine.

### 15.4. Faulty plans

15.4.1. If mine plans are found to be inaccurate or deficient, the competent authority should be empowered to have the mine surveyed and new plans prepared at the expense of the employer and/or suspend or restrict mining activity on safety and health grounds, until the condition has been corrected.

### 15.5. Abandonment plans

15.5.1. No mine or part of a mine should be abandoned until the mine plans, including an accurate survey of all areas where mining was conducted, have been brought up to date.

15.5.2. Where abandonment results from an unforeseen emergency which makes access to the mine workings highly dangerous, the requirements under paragraph 15.5.1 should not apply. In such a case, as much relevant information as possible should be collected for the purpose of bringing the plan up to date.

15.5.3. Abandonment plans should contain all the information specified in national laws or regulations together with any other information which may affect the safety of neighbouring

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mine workings; such plans should be endorsed with a certificate from a certified mining engineer/surveyor attesting to their accuracy and any limitations thereon.

15.5.4. Abandonment plans should be examined by the competent authority for compliance with the requirements of national laws or regulations; they should then be stored in a depository specified by the competent authority and a proper register should be kept of all plans so stored; the register and plans should be made available to persons having a legitimate interest in them.

## **16. Commencement and cessation of mining operations**

Where national laws, regulations and standards do not contain prescription or contain ineffective or outdated prescription as to commencement and cessation of mining operations, this chapter provides guidance. The provisions outlined in this chapter should be used in conjunction with the proper application of a hazard identification, risk assessment and control process.

### **16.1. Commencement and cessation of mining operations: General**

16.1.1. The employer should ensure that the mine is commissioned, operated, maintained and decommissioned in such a way that the workers can perform the work assigned to them without endangering their safety and health or that of other persons.

16.1.2. Every mine should be registered with the competent authority by the employer.

16.1.3. It should be the duty of the employer to notify the competent authority:

- (a) before any mining operations are commenced at a new mine;
- (b) before any new working is commenced for the purpose of:
  - (i) opening any new shaft, other outlet or seam; or
  - (ii) exploring a new level, or any other important extension of an existing mine where required by national laws;
- (c) before recommencing the working of any shaft or outlet, or of any seam after their abandonment or discontinuance for a period to be defined by national laws or regulations; and
- (d) of the abandonment or discontinuance of any mine or seam or, where national laws or regulations so require, the abandonment or discontinuance of any area of a mine or seam, within a period which should be specified in national laws or regulations.

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16.1.4. National laws or regulations should require such precautions on abandonment as are necessary to ensure the safety of workings in adjacent mines or in parts of the mine where work is to be continued.

16.1.5. Where a change occurs in the ownership or the name of a mine, the employer should, within a period which should be specified in national laws or regulations, notify the competent authority of the change.

### **16.2. Posting of notices**

16.2.1. The employer should, in the manner prescribed by national laws or regulations, bring to the notice of all concerned:

- (a) laws or regulations relating to safety and health or such extracts from them as may be prescribed by the competent authority;
- (b) instructions issued by the competent authority in matters of safety and health, or such extracts from them as may be prescribed by the competent authority;
- (c) instructions, plans and procedures prepared by the employer or subordinates in matters of safety and health, or extracts from these instructions, where the preparation is prescribed by the competent authority; and
- (d) mining plans that are required by national laws or regulations and competent authorities.

16.2.2. All notices that are required to be posted should be promptly renewed when they become defaced, obliterated or destroyed; where practicable, such notices should be protected from the effects of weather.

## **Commencement and cessation of mining operations**

### **16.3. Records and returns**

16.3.1. All records, reports, plans or other documents required by national laws or regulations should be kept at the office of the mine and be available for inspection by the competent authority and the workers' representatives, unless the competent authority directs otherwise.

16.3.2. The employer should send to the competent authority such returns and statistics as may be required relating to the safety and health matters at the mine.

## **17. Means of access and egress, including hoisting of persons and material**

Where national laws, regulations and standards do not contain prescription or contain ineffective or outdated prescription as to means of access and egress, including hoisting of persons and material, this chapter provides guidance. The provisions outlined in this chapter should be used in conjunction with the proper application of a hazard identification, risk assessment and control process.

### **17.1. Provision of means of access and egress**

17.1.1. Except for the duration of shaft sinking or the drivage of other means of access and egress from the mine, together with the necessary development work, there should be, as far as practicable, two separate means of access to and egress from the underground workings.

17.1.2. At each working level or inset for the means of access and egress specified in paragraph 17.1.1 where persons are expected to ride or be hoisted, there should be a way to the alternative means which should follow a direct route and should be travelling with reasonable convenience.

17.1.3. (1) As far as practicable, two ways should be provided from every working place, and each of these should be connected to a separate and alternative means of egress to the surface.

(2) As specified in paragraph 9.3.3, in mines there should be provided, as far as practicable, two main intake airways so separated that, if one becomes contaminated with the products of a fire, the other is clear for a safe means of escape from the mine for the persons below ground.

## Means of access and egress

(3) As specified in paragraph 9.3.5, in all mines where two main intake airways are not provided, the one main intake should, as far as practicable, be so constructed and equipped that it is free from the risk of fire; mines should be constructed with two intakes.

17.1.4. Where places in the workings of the mine do not contain the two means of egress from each working place as specified in paragraph 17.1.1 with each of them crossing a common junction, the national laws or regulations should state the maximum number of persons allowed in such places; however, where a junction consists of an explosion-proof crossing, this should not be considered to be a common junction.

17.1.5. In a case where the two separate and independent means of egress are not situated in the same mine, managers should be responsible for that part of it situated in their mine; any occurrence that may affect the safe use of such means of egress should be immediately reported to the competent authority and to the manager of the mine affected.

17.1.6. Both the means of egress and the equipment used therein for the transport of persons should be kept constantly in a safe condition to facilitate ease of travelling, including clearances for hand-carried stretchers, and a ready means of egress.

17.1.7. All practicable precautions should be taken to ensure that, where the only means of egress are hoisting shafts or unwalkable outlets, the hoisting or haulage engines, as the case may be, do not fail simultaneously; in particular, in the case of electric hoisting or haulage engines, an alternative electric power supply should be available.

17.1.8. (1) The employer at every mine where there are personnel hoisting shafts more than 50 metres (approximately 160 feet) deep should ensure that there is at all times in force a

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plan to provide and maintain apparatus by which persons employed below ground in the mine have means of egress in an emergency.

(2) The plan should provide for:

- (a) the constant availability of emergency hoisting apparatus; and
- (b) the use of gravity hoisting apparatus capable of withdrawing the persons underground safely and efficiently.

Such emergency hoisting apparatus is to be tested at specified intervals if it is not in regular use.

17.1.9. All shafts and outlets should be thoroughly examined by a competent person at intervals which should be stated in national laws or regulations.

17.1.10. The surface entrance to every mine shaft and every other entrance, whether above or below ground, should be provided with an efficient enclosure so designed and constructed as to prevent any person accidentally falling down the shaft or coming into contact with a moving part of the hoisting equipment provided in the shaft.

17.1.11. All entrances to the mine shaft should be:

- (a) adequately illuminated throughout working hours;
- (b) provided with gates or other safety equipment to prevent persons or mine cars or other equipment inadvertently falling down the shaft when the cage is not at the landing; and
- (c) provided with adequate facilities to enable persons to pass safely from one side of the shaft to the other, where necessary.

17.1.12. Where weather conditions are such that ice may form in shafts, suitable devices should be installed to minimize the risk; where ice does form in a shaft, it should be removed as soon as practicable in a safe manner.

17.1.13. All surface and seepage water should be channelled in such a way as to prevent it from falling freely into the shaft.

17.1.14. Shafts should, as far as possible, be kept clear of accumulations of loose objects, coal and dirt.

17.1.15. There should be at least two means of signalling between each of the shaft stations and the hoist room. A telephone communication system should be installed in all personnel hoisting shafts, in addition to the other signal appliance.

17.1.16. All equipment used in the repair and maintenance of shafts should be of suitable material and of sound construction; as far as reasonably practicable, it should be specifically built for this work.

17.1.17. Each person doing repair and maintenance work in shafts should wear and use a properly designed safety harness, attached to suitable anchorage points, and designed and made to a suitable national standard.

17.1.18. Work in isolation on shaft repair and maintenance should be prohibited.

## 17.2. Ladder ways

17.2.1. In shafts not exceeding 50 metres (approximately 160 feet) in depth, ladder ways may be provided as an alternative to the requirements of paragraph 17.1.8.

17.2.2. In hoisting shafts, the ladders should be in a separated compartment, adequately fenced off from the hoisting compartment.

17.2.3. Ladder ways should be:

- (a) so installed as to allow safe travel;
- (b) kept in a safe condition; and

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(c) regularly inspected at intervals which should be specified in national laws or regulations.

17.2.4. Every ladder should be of suitable material, adequate strength, properly treated, securely fixed in position and maintained in good repair.

17.2.5. Ladders should not be sloped at an angle exceeding 80 degrees except in sinking shafts where the ladders are so arranged that continuous support is afforded to the worker's back.

17.2.6. In all ladder ways, rest platforms should be installed as far as practicable and not more than 10 metres (approximately 33 feet) apart.

17.2.7. Ladders should extend at least 1 metre (approximately 40 inches) above the platforms and the bank; where this is not the case, fixed hand grips should be fitted.

17.2.8. Ladders should be so placed as to cover the manholes of the rest platforms immediately below.

17.2.9. (1) When persons are travelling on ladders, the mine lamps, tools and any other objects they carry should be secured against falling.

(2) Manholes in platforms should have openings of sufficient size to permit the passage of persons wearing rescue apparatus.

### **17.3. Hoisting installations at shafts and unwalkable outlets**

#### **17.3.1. General provisions**

17.3.1.1. Competent persons appointed by the mine manager for this purpose should, at least once in every 24 hours, inspect the state of:

(a) the external parts of machinery; and

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- (b) the headgear, ropes, chains, connecting pieces, cages and other similar appliances, which are in actual use for the purpose of raising or lowering persons in a mine, and over-speed, over-wind and other safety controls.

17.3.1.2. At least once each week, the state of the shafts in which persons are lowered or raised should be examined; for this purpose, properly designed safety harnesses should be worn and used.

17.3.1.3. The results of the inspections specified in paragraphs 17.3.1.1 and 17.3.1.2 should be recorded in a register which should be available to all authorized persons.

17.3.1.4. The environment of the hoisting-engine house should be controlled in such a way as to prevent sudden changes of atmospheric conditions that might cause condensation to form on the brake path of the engine and thus impair brake efficiency; brake paths should also be kept free from dirt and other contamination.

17.3.1.5. Devices to detect slack hoisting rope should be installed, where required, at person-hoisting installations.

17.3.1.6. All parts of hoisting installations, including suspension gear at shafts and unwalkable outlets, should be of sound construction, suitable material and adequate strength, maintained in safe working order by appropriate treatment and inspection, and kept constantly available for use.

17.3.1.7. All parts of hoisting installations at shafts and unwalkable outlets should be firmly connected to a rigid foundation.

17.3.1.8. Where drum clutches are used, every hoisting engine should be fitted with a suitable interlocking device so that it is impossible:

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- (a) to disengage the clutch on any drum unless the brakes of such drum are on; and
- (b) to release the brakes until the drum clutch is fully engaged and securely locked.

17.3.1.9. Friction hoister (Koepe) pulleys should be:

- (a) of ample diameter, having regard to the size and construction of the rope used; and
- (b) kept in such condition that rope-slip is minimized.

### **17.3.2. Drums**

17.3.2.1. Cast iron drum shafts should be prohibited; national laws or regulations may provide for drum shafts above a stated diameter to be bored longitudinally at the centre.

17.3.2.2. Drums should be provided with flanges or horns and also, if the drum is conical, with other appliances that effectively prevent the rope from slipping.

17.3.2.3. Except in the case of friction hoister (Koepe) pulleys, the rope end should be properly secured to the drum and there should be not less than two turns of rope on the drum when the cage is at the lowest point of its travel.

### **17.3.3. Depth indicators**

17.3.3.1. Hoisting engines should be equipped with a reliable depth indicator and a bell that will automatically ring at the appropriate moment; the indicator should be easily seen and the bell clearly heard by the person operating the hoisting engine.

17.3.3.2. Markings indicating crucial points in the shaft should also be made on the drums or, in the case of friction (Koepe) hoisting, on the rope.

17.3.3.3. The depth indicators should be checked at least daily for accuracy and tested where necessary; they should be adjusted after every change of the cage's travel and after every capping or rope change.

### 17.3.4. Speed indicators

17.3.4.1. National laws or regulations should require that the regular person hoisting plant in main shafts used for hoisting more than a specified number of persons per day be equipped with a speed indicator situated in such a way that the hoisting speed can at all times be easily read by the engine-driver from the seat of operation.

### 17.3.5. Brakes

17.3.5.1. Mechanically powered apparatus for raising or lowering persons should be equipped with at least two separate brake systems on the drum or drum shaft, which should bring the cage or cages to rest at not more than a specified rate of retardation when the maximum out-of-balance load is applied in either direction, as appropriate.

17.3.5.2. Brakes should be arranged to act automatically if the power fails.

17.3.5.3. In the event of failure of one of the braking systems, at least 50 per cent of the braking effort should still be available for the safe control of the engine.

### 17.3.6. Overwind preventers and speed controllers

17.3.6.1. National regulations should specify the speed above which hoisting engines should be equipped with an automatic control.

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17.3.6.2. Every hoisting engine which is used for person hoisting should be equipped with an automatic overwind preventer unless exempted by the competent authority.

17.3.6.3. During person hoisting, the automatic speed controller should:

- (a) prevent any descending cage from passing the bottom landing place at a speed exceeding 4 metres (approximately 13 feet) per second where the sump and headgear are in accordance with sections 17.5 and 17.7 and with any further requirements of the competent authority;
- (b) prevent any descending cage from landing on the pit bottom or other permanent landing at a speed exceeding 1.5 metres (approximately 5 feet) per second; and
- (c) cut off the supply of power to the engine and apply the brakes when any cage travels too far above its normal highest position at the top landing place.

17.3.6.4. (1) Automatic speed controllers and overwind preventers should, unless they are permanently in full and fixed engagement with the hoisting engine, be fully engaged, either automatically or by the hoisting engineman, whenever persons are to be raised or lowered.

(2) A proper automatic indicator to show that this has been done should be installed in a position where it can be easily seen by the banksman.

17.3.6.5. No person should be allowed to enter any cage until the indicator shows that the automatic speed controller and the overwind preventer have been fully engaged.

17.3.6.6. (1) The automatic speed controller and overwind preventer should be tested in a manner and at intervals prescribed by the competent authority.

(2) The results of the tests should be recorded in a register.

17.3.6.7. Before the beginning of every period of regular person hoisting after a cessation of hoisting exceeding four hours, and notwithstanding the daily inspections required by paragraph 17.3.1, trial hoists should be carried out between the points in the shaft in which regular person hoisting is to be undertaken.

#### 17.4. Guides

17.4.1. All hoisting shafts in which cages or skips are used should be provided with guides.

17.4.2. The guides, buntons and fastenings should be of sufficient strength.

17.4.3. The clearance of the cages from each other and also from the shaft sides should be such that the free passage of the cages remains ensured in all circumstances.

#### 17.5. Sumps

17.5.1. (1) Where national laws or regulations require the provision of sumps, a suitable space should be provided under the lowest position of the cage at the bottom landing place.

(2) The depth of this space should be at least equal to the clear height provided at the top of the shaft under paragraph 17.7.1.

17.5.2. Where appropriate, buffers or other devices should be installed to minimize the danger to persons riding in a descending cage.

17.5.3. (1) The sump should be kept sufficiently clear of water to ensure that there can be no danger of persons riding in the cage being submerged if it is lowered too far.

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(2) The level of water, if any, in the sump should be kept below any guide weights or attachments which should be kept free for inspection.

17.5.4. The sump should be provided with a ladder leading to the nearest landing, or with other suitable means of egress.

### **17.6. Keps, safety stops**

17.6.1. (1) If keps are used for mineral-hoisting, arrangements should be made to block them securely in the off position.

(2) When keps are blocked in the off position, they should leave the shaft clear for the passage of the cage.

### **17.7. Headgear and rope pulleys**

17.7.1. The competent authority should specify the clear height to be provided between the pulley and the top of the cage when in its highest position at the top landing place.

17.7.2. (1) Headgear catches or other safety appliances to minimize dangers from overwinding should be fitted.

(2) The correct operation of these devices should be tested at least once per week.

17.7.3. The headgear should be maintained in sound structural condition, and any accumulation of greases or other flammable material should be promptly removed.

17.7.4. (1) Rope pulleys should be of sound construction having regard to the size and construction of the rope used.

(2) Fenced access platforms should be provided.

### **17.8. Cages**

17.8.1. No person should ride through a shaft or unwalkable outlet except in a cage which complies with the requirements in paragraphs 17.8.2 to 17.8.9 except:

## Means of access and egress

- (a) for the purpose of sinking operations;
- (b) for the purpose of examining or repairing a shaft or outlet or any machinery or appliances therein;
- (c) for the purpose of accompanying bulky plant or machinery that cannot be raised or lowered in such a cage;
- (d) in pursuance of an exemption granted by the competent authority; or
- (e) for rescue work, where the cages are not adequate for the purpose of rescue.

17.8.2. The cage should be provided with a strong protective roof.

17.8.3. On each deck, bars or handrails should be provided for the passengers to hold on to.

17.8.4. During person hoisting, the cage should be safely enclosed in such a way that nothing can project into the shaft.

17.8.5. The gates should not open outwards, and they should be so set that they cannot be thrown open by jolting or movement of the cage.

17.8.6. The cage should be provided with catches or other suitable contrivances to prevent vehicles falling out.

17.8.7. The manager should specify the maximum number of persons allowed in each cage or on each deck of a cage, subject to such requirements as may be specified by the competent authority.

17.8.8. The bottom of the cage should be so designed as to withstand impacts and stresses produced during normal and emergency landings.

17.8.9. Cages should be high enough for persons to stand upright.

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### **17.9. Detaching gear**

17.9.1. Where mechanically operated hoisting apparatus is normally used for carrying persons through a shaft, appropriate gear should be provided for detaching each ascending cage from the rope and holding it stationary in the event of overwinding.

17.9.2. National laws or regulations should establish requirements concerning the construction, installation, maintenance, inspection and testing of detaching gear.

17.9.3. In special circumstances, the competent authority may exempt any mine from the requirement to provide detaching gear.

17.9.4. Proper means should be provided to gain access to overwound cages.

### **17.10. Suspension gear**

17.10.1. (1) Capels and connecting pieces between the hoisting rope and the cage should possess an adequate factor of safety in relation to the maximum static load and with due allowance for dynamic stresses.

(2) National laws or regulations should prescribe the factor of safety and the quality of the materials to be used.

17.10.2. Where emergency chains are used, their length should be such that, if the king bolt breaks, the shock with which the cage is held is as slight as possible.

17.10.3. Ample provision should be made for the safety of the connecting pieces between the tail rope, where used, and the cage.

17.10.4. National laws or regulations should require that the suspension gear between the hoisting rope and the cage (chain, detaching hooks and other attachments) be examined at specified intervals and by approved techniques.

17.10.5. The responsible engineer should see that defective parts are changed or receive such treatment as is necessary.

17.10.6. All parts of suspension gear should be renewed after a period of service to be specified in national laws or regulations.

17.10.7. Before a new or renewed set of suspension gear is used, it should be subjected to appropriate non-destructive testing.

17.10.8. The results of the tests and other treatment given should be entered in the register.

17.10.9. If any part of suspension gear between the cage and the main hoisting rope or the tail rope is broken, all available pieces of the broken part should be kept for inspection:

- (a) by the competent person appointed by the manager; and
- (b) by a person appointed by the competent authority.

## 17.11. Hoisting ropes

17.11.1. All hoisting ropes should be of suitable material and construction and of adequate strength, in accordance with national laws or regulations.

17.11.2. National laws or regulations should prescribe the quality of materials to be used and fix the conditions under which the testing of ropes (and, in respect of wire ropes, of the individual wires) is to be conducted, and the standards to be met.

17.11.3. A certificate from the manufacturers, stating that the rope complies with national laws or regulations, should be furnished for every hoisting rope and inserted in a register.

17.11.4. Every drum or reel-hoisting rope should at all times possess an ample factor of safety in relation to the maximum static load in material hoisting, with due allowance for dynamic stresses.

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17.11.5. Where any system of hoisting is in operation which does not permit periodically cutting off pieces of rope for testing, the safety factor of the rope should be correspondingly increased or the stated life of the rope should take into account this factor.

17.11.6. The maximum load in person hoisting should not exceed a percentage of the maximum load in mineral hoisting to be specified in national laws or regulations.

17.11.7. (1) Before its first use for regular person hoisting, every hoisting rope should make at least 20 winds with the ordinary load of coal and be found free from any visible defect.

(2) This requirement should also apply when the rope capping or the suspension gear has been renewed.

17.11.8. National laws or regulations should specify the life of hoisting ropes, and no rope should be used beyond this stated period except by permission of the competent authority.

17.11.9. No spliced ropes should be used for person hoisting at any shaft or unwalkable outlet.

17.11.10. (1) Every hoisting rope and counterweight rope should undergo the following daily and monthly examination:

- (a) a daily examination should be carried out by a competent person, with the rope passing at a speed not exceeding 1 metre (approximately 3.2 feet) per second; and
- (b) a monthly examination in appropriate conditions should be undertaken by a competent person, the rope being passed at a speed not exceeding 0.5 metres (approximately 19 inches) per second after it has been cleaned of encrusted dirt and grease.

(2) In addition, parts of the rope throughout its length, not more than 100 metres (approximately 320 feet) apart and those particularly liable to deterioration, should be cleaned and examined;

the rope circumference should be measured and the surface condition of the rope thoroughly examined, including a search for fractured wires.

(3) Electronic or equivalent examination methods approved by the competent authority may be used in place of those required in subparagraphs 17.11.10(1) to 17.11.10(2).

17.11.11. The results of the abovementioned examinations should be recorded in a register.

17.11.12. (1) National laws or regulations should state the interval and the procedures to be observed for the recapping of ropes.

(2) These procedures should specify that:

- (a) except in systems which do not so permit, a piece of rope of sufficient length should be cut off, opened and its internal conditions examined in a manner specified by the competent authority; and
- (b) suitable tests of the rope and of individual wires should be applied as required by national laws or regulations.

## 17.12. Tail ropes

17.12.1. When tail ropes are used, they should be of suitable material and of sound construction.

17.12.2. National laws or regulations should define the working life of the tail rope, the tests to be made and the standards to be satisfied during that working life.

17.12.3. Withdrawn hoisting ropes should not be used as tail ropes unless they are carefully examined, found to be in good condition and in all respects suitable for use for that purpose.

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17.12.4. The free hang at the bottom of the shaft should be such that the upper cage can travel to the highest possible position in the headframe without being hindered by the tail rope.

17.12.5. Devices should be fitted to prevent the tail rope from being distorted.

17.12.6. The shaft sump should be kept clear of water to prevent the tail rope from running in water.

17.12.7. (1) The tail rope should be examined weekly by the competent person appointed under paragraph 17.3.1.1.

(2) During this examination of the rope, speed should not exceed 0.5 metres (approximately 19 inches) per second.

(3) The results of the examination should be entered into a register.

### **17.13. Duties of hoist operator at shafts or unwalkable outlets**

17.13.1. A hoist operator should not leave the control gear when the engine is in motion or when he/she has cause to believe that a person is in the cage.

17.13.2. If a hoist operator finds, during the course of duty, a defect likely to affect the proper working of the apparatus, the engine should not be put into motion again until the defect has been reported to the supervisory official and such official has instructed the hoist operator to set the engine in motion.

17.13.3. The hoist operator should not allow any other person to operate the engine for which he/she is responsible unless that person is properly authorized.

17.13.4. The hoist operator should not set the hoist in motion in response to any signal transmitted that is indistinct or in response to any series of signals which appears to be incomplete or inconsistent.

17.13.5. National laws or regulations should specify the minimum age at which a hoist operator may be appointed.

17.13.6. (1) National laws or regulations should specify the hours of employment of hoist operators.

(2) Hoist operators should be physically and mentally fit and be qualified in accordance with national laws or regulations.

#### **17.14. Signalling appliances**

17.14.1. Every manually operated personnel hoist or person-hoisting plant should have an efficient signalling system for giving both audible and visible signals:

- (a) from each landing to the bank, surface landing or top of the shaft and vice versa; and
- (b) from the bank to the hoist operation room.

17.14.2. All signals, both visual and audible, transmitted from the landings to the surface should be transmitted to the banksman and the hoist operator.

17.14.3. Defects in the signalling system should be immediately reported to a supervisory official, who should take action to have the defects remedied.

17.14.4. In shafts with two hoisting installations, the audible signals should differ distinctly in tone.

17.14.5. Where, in person hoisting, two or more decks of a cage are entered and left simultaneously, each floor at the landing or at the bank should be connected by an effective signalling system with the main loading point of the landing or bank, and only the signaller

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at that point should give the action signal, after all decks are known to be clear and closed.

17.14.6. Electrical signalling systems should be interlocked with other equipment in a manner that prevents inadvertent movement of the cages.

17.14.7. The landings, the bank and the hoist operator should be in telephonic communication.

### **17.15. Signalling operations**

17.15.1. For the purpose of transmitting and receiving signals, an authorized person should be in constant attendance:

- (a) at the top of every shaft by which any persons are about to be lowered;
- (b) so long as any persons are in the mine below ground, at the top of every shaft from which persons may need to be raised; and
- (c) unless all persons in the mine are supervisory officials or persons authorized in writing by the manager to give signals, at every shaft from which persons may need to be raised.

17.15.2. At the bank and the landings, only one signaller on each shift should give signals for each hoisting plant.

17.15.3. Signallers should be responsible for the clear and safe operation of the signals.

17.15.4. The code of signals should be fixed or approved by the competent authority, and, where practicable, should be uniform for all mines in the same district; in any case, the stop signal of one ring should be uniform everywhere.

17.15.5. Wherever signals are given or received, the signalling code should be posted and observed; no signals should be given without proper authority.

17.15.6. Before persons enter a cage to be wound, a special signal should be given by the signaller at the landing concerned to the signaller at the bank and an acknowledgement signal received.

17.15.7. The manager should fix the signals and the manner in which they are given:

- (a) at times when no signaller is on duty; and
- (b) for shaft inspections or repair work.

17.15.8. Electrical signalling systems should be regularly maintained.

17.15.9. Where national laws or regulations permit automatic person hoisting, the requirements of this subsection should not apply, provided other adequate safeguards to minimize hazards with respect to transportation of persons are stipulated.

## **17.16. Person-hoisting operations**

17.16.1. Material should not be hoisted in any compartment of the shaft while regular person hoisting is in progress.

17.16.2. With the consent of the competent authority, exceptions may be made for a shaft equipped with two hoisting plants.

17.16.3. Occasional person hoisting in conjunction with material should be allowed only in accordance with the requirements of national laws or regulations and under specific conditions.

17.16.4. Whenever the hoist operator has occasion to leave the hoist engine, he/she should apply the brakes, cut off the power and take any other steps as may be necessary to ensure that the engine cannot be restarted by an unauthorized person.

17.16.5. The use of skip-hoisting plant for person hoisting should be permitted only where the skips either comply with or

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provide facilities equivalent to those required for cages under section 17.8.

17.16.6. Engine rooms should be equipped with emergency lighting which is either continuously in operation or is automatically switched on when the main lighting fails.

17.16.7. Where any defect is found in any plant covered by this chapter, person hoisting should be discontinued until the defect has been either remedied or other measures taken to enable person hoisting to proceed in a safe manner.

### **17.17. Automatic elevators**

17.17.1. The doors of automatic elevators should be equipped with interlocking switches so arranged that the elevator car will be immovable while any door is open or unlocked, and arranged so that such door or doors cannot be inadvertently opened when the elevator car is not at a landing.

17.17.2. A stop switch should be provided in the automatic elevator compartment that will permit the elevator to be stopped at any location in the shaft.

17.17.3. A slack cable device should be used when appropriate on automatic elevators which will automatically shut off the power and apply brakes in the event the elevator is obstructed while descending.

17.17.4. Each automatic elevator should be provided with a telephone or other effective communication system by which aid or assistance can be obtained promptly.

17.17.5. All the applicable provisions of Chapter 17 should apply to automatic elevators.

**17.18. Shaft sinking, deepening or raising: General**

17.18.1. In addition to other examinations of the shaft required by this section, a competent person appointed by the mine manager should, at least each shift, examine the working conditions and ventilation and, once in every 24 hours, thoroughly examine the state of the shaft and the state of all gear by which cradles, platforms or pumps are lowered in the shaft.

17.18.2. Every cradle or platform used in the shaft should, when necessary, be constructed with a grid or other suitable contrivance to secure the efficient ventilation of the whole of the shaft.

17.18.3. Each cradle or platform should have its maximum load posted on it, and it should be the duty of supervisory officials to verify that the maximum load is not exceeded.

17.18.4. (1) National laws or regulations should specify the precautions to be taken while persons are working on any cradle or platform in the shaft, and particularly to prevent falls of persons.

(2) Where two or more parts of the cradle or platform are hinged together, those parts should be securely bolted together whenever work thereon is in progress.

17.18.5. If sinking is done from the surface, and the work is carried on during the night, the surface of the shaft top should be adequately illuminated.

17.18.6. A supervisory official should, during his or her shift, have entire charge of the operations at the shaft bottom, subject to the directions of the manager or any person appointed for this purpose by the manager.

17.18.7. Immediately before the descent of a shift, or if work is carried on without an interval by a succession of shifts, the supervisory official should carry out a general safety examination during

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his/her shift and satisfy himself/herself that the shaft is in a safe condition for persons to work at the bottom or on any walling or tubing operation.

17.18.8. The supervisory official should be the last person to ride at the end of the shift, and if this shift is succeeded immediately by another shift, that supervisory official should not leave the bottom of the shaft until the descent of the supervisory official of the next shift.

17.18.9. No person should be allowed to descend after any cessation of work in the shaft caused by the withdrawal of the workers for shot-firing or other purposes, until the supervisory official has examined the shaft and found it to be safe in all respects.

17.18.10. If methane has been found or is likely to be found in the shaft, the examination should be made with an approved flame safety lamp or an approved methane detector serving the same purpose.

17.18.11. The banksman should keep the shaft top and landing edge free from loose materials at all times.

17.18.12. (1) When a shaft is being sunk through water-bearing strata, adequate means of escape from the bottom of the shaft should be provided, and the work conducted in accordance with a scheme specially prepared by the manager.

(2) The scheme should be submitted to the competent authority who should require any amendment thought to be necessary in the interests of the safety of the persons employed in the shaft.

### **17.19. Hoisting of persons and materials at sinking shafts**

17.19.1. All hoisting equipment, including winches, guides, ropes, chains, connecting pieces, buckets, platforms and their associated equipment and similar appliances should be:

## Means of access and egress

- (a) of suitable material, good construction, adequate strength and free from patent defect;
- (b) inspected in accordance with the general rules laid down in this section; and
- (c) maintained in safe working condition.

17.19.2. Where multi-rope suspension is used for a cradle or platform, individual rope loads should be measured to ensure that no one rope is overloaded.

### 17.20. Sinking shafts

17.20.1. An appropriate clear height should be provided between the pulley and the top of the bucket when resting at the surface.

17.20.2. As soon as the shaft, or the newly deepened part of a shaft, reaches a depth specified in national laws or regulations, rope guides for the bucket should be installed.

17.20.3. A shaft should be closed at the shaft top by flaps or trap doors, which should be opened only when required for the passage of the bucket or of material.

17.20.4. The shaft bottom should be adequately illuminated throughout working hours.

### 17.21. Hoisting engines or winches at sinking shafts

17.21.1. Before a winch is installed at a sinking shaft site, it should be the duty of the employer to establish that it is properly designed for that installation and fully capable of meeting any demands likely to be made on it.

17.21.2. The winch should be provided with a reliable depth indicator and with such other means as may be necessary to indicate

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to the operator when the bucket or the counterweight is approaching the shaft top.

17.21.3. The winch should be provided with brakes satisfying the requirements of paragraphs 17.3.5.1 to 17.3.5.3, and equipped with a properly designed clutch/brake interlocking arrangement.

### **17.22. Suspension gear at sinking shafts**

17.22.1. (1) National laws or regulations should specify the requirements to be satisfied by suspension gear which should be of a standard at least equal to that required by the relevant parts of this section.

(2) Particular attention should be given to breaking strength, capels and the device for the prevention of bucket rotation.

### **17.23. Signalling appliances at sinking shafts**

17.23.1. Efficient signalling appliances should be provided for signalling between the working places in the shaft, the shaft top and the winch hand.

17.23.2. Signalling appliances should be operated only by the charge hand or the signallers appointed for the purpose.

17.23.3. It should, however, be possible for any person to operate the signalling appliances from the bucket at any point in its course.

17.23.4. Signalling appliances should be examined daily.

### **17.24. Hoisting operations at sinking shafts**

17.24.1. National laws or regulations should fix the maximum person-hoisting speed, and hoisting cable size and strength specifications.

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17.24.2. When lowering the bucket, the hoisting operator should stop it 6 metres (approximately 19 feet) above the point to which it is being lowered, and should not lower it further until he/she has received another signal to do so.

17.24.3. (1) When raising the bucket, the hoisting operator should stop it 1–2 metres (approximately 3–6 feet) above the point from which it is being raised to enable it to be steadied and cleaned.

(2) It should not be raised further until another signal to do so has been given.

17.24.4. The supervisory official or the persons authorized to transmit signals at the bottom of the shaft should ensure that the bucket is properly loaded, and in particular that:

- (a) no mineral projects above the rim;
- (b) tools, equipment or other materials are not loaded together with mineral;
- (c) when objects projecting above the rim are carried, they are securely fastened to the bow or chains supporting the bucket;
- (d) nothing capable of causing injury is adhering to the outside of the bucket; and
- (e) when the bucket is being raised, it is in line with the pulleys and carefully steadied.

17.24.5. When anything is to be lowered, otherwise than in a bucket, it should be the duty of the banksman, or other person authorized to transmit signals, to ensure that it is safely slung.

17.24.6. No person should be wound or hoisted without a light except in an emergency.

17.24.7. No person should enter or leave a bucket at the top of the shaft or at any working platform before the flaps or trap doors

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or protective canopy at the top of the shaft or at the working platform have been closed.

17.24.8. No person should be carried on the edge of the bucket except for the purposes of shaft inspection.

17.24.9. Any inspecting person should be protected from falling by wearing and using a properly designed safety harness.

17.24.10. No person should be carried in a partly or fully loaded bucket.

17.24.11. When two buckets are used, neither bucket should be used for material hoisting while person hoisting is in progress.

17.24.12. When any person is at work on a cradle or platform, the bucket should be secured to the side of the shaft by means of steady-jacks or other devices to prevent it swinging.

### **17.25. Shot-firing at sinking shafts**

17.25.1. Subject to the provision of the following requirements, shot-firing during shaft sinking should comply with the requirements stated in Chapter 13.

17.25.2. Shot-firing should be carried out only by competent and properly authorized persons.

17.25.3. The primers should be prepared only in a special place designated by the manager.

17.25.4. The explosives should be brought to the bottom in closed containers, and only when they are immediately required for use.

17.25.5. Special containers should be provided for detonators.

17.25.6. No shot-firer should couple a shot-firing cable to a detonator in a shaft provided with hoisting apparatus unless:

## **Means of access and egress**

- (a) the bucket is conveniently placed for persons in the shaft to enter it; and
- (b) the hoist operator is ready to raise.

17.25.7. While the leads are being joined and the connection made to the firing line, only those persons needed for the operation, in addition to the shot-firer, should be present.

17.25.8. All shots should be fired electrically.

17.25.9. The cable should not be coupled to the firing apparatus until all persons are in a place of safety.

17.25.10. The shot-firer should be the last person to leave the bottom.

## **18. Roads**

Where national laws, regulations and standards do not contain prescription or contain ineffective or outdated prescription as to roads, this chapter provides guidance. The provisions outlined in this chapter should be used in conjunction with the proper application of a hazard identification, risk assessment and control process.

### **18.1. Safety of roads**

18.1.1. It should be the duty of the manager of every mine, with respect to every road in the mine, to take such steps to control movement of the strata in the mine and support the roof and sides of every road as may be necessary to keep every road secure.

### **18.2. Height and width of travelling roads**

18.2.1. Every length of road in a mine which is used at the beginning or end of a shift by persons, for the purpose of walking to or from their working places in the mine, should be not less in height and width than specified in national laws or regulations.

18.2.2. Roadways should be constructed of such height and width as to be travelling with reasonable convenience.

### **18.3. Fencing or sealing of unfit parts of mine roadways**

18.3.1. Every entrance from a road in a mine to a part of the mine, that for the time being is not maintained in a state fit for persons to work in or pass through, should be provided with an efficient enclosure or barrier that should prevent any person from accidentally entering that part of the mine.

18.3.2. Every enclosure or barrier should be properly maintained, and an appropriate notice prohibiting entry, except to authorized persons, should be posted where it can be seen easily by all concerned.

18.3.3. Where, due to atmosphere or other conditions, emissions of dangerous concentrations of noxious or flammable gas occur from such unfit parts of the mine, the entrance to every such part should be effectively sealed and suitable arrangements made, where necessary, to discharge the emissions in a safe manner.

#### 18.4. Inclined roadways and workplaces

18.4.1. On inclines with a slope exceeding 45 degrees, repairs should be undertaken only from platforms or when using adequate safety harnesses.

18.4.2. Bunkers, chutes and the delivery end of conveyors should be so arranged that no person is endangered by falling coal or other objects.

18.4.3. Persons who are required to enter bunkers or chutes should wear and use safety harnesses, take other precautions as are necessary and should have a second competent person present.

18.4.4. Stairs, platforms or steep walks in a mine should be provided with rails, fences or gates as may be necessary for the protection and safety of persons.

18.4.5. Persons working in steep roadways or steep seams should be protected, as far as practicable, against falling pieces of rock, coal or other objects.

## 19. Haulage and transport

Where national laws, regulations and standards do not contain prescription or contain ineffective or outdated prescription as to haulage and transport, this chapter provides guidance. The provisions outlined in this chapter should be used in conjunction with the proper application of a hazard identification, risk assessment and control process.

### 19.1. Transport rules

19.1.1. (1) National laws or regulations should require, and it should be the duty of the manager of every mine to formulate, transport rules with respect to every road in the mine used for the transport of persons and material.

(2) Such transport rules should include and specify:

- (a) the standard height and width with respect to each length of road in which vehicles are run or conveyors operated;
- (b) the minimum clearances between loads and the roof and sides of the roads along which such loads are transported;
- (c) that conveyor belts and the materials they carry should not be allowed to rub against roof supports, belt frame structures, the roof or the sides of roadways;
- (d) the maximum loads to be transported in terms of number of vehicles, weight, dimensions or other criteria;
- (e) the maximum speed at which vehicles may run;
- (f) the standard of track and haulage appliances to be used; and
- (g) the special procedures which must be observed at specified points on the haulage system.

19.1.2. A clearly understandable copy of the transport rules should be posted at both ends of the roadway to which the rules apply.

**19.2. Haulage plant inspection and maintenance scheme**

19.2.1. It should be the duty of the manager of every mine to formulate a scheme for the systematic and regular inspection and maintenance of all haulage plant in the mine.

19.2.2. The manager should appoint sufficient competent persons to ensure that the requirements of the scheme are fulfilled.

**19.3. Haulage: General provisions**

19.3.1. Every haulage road should be as regular in gradient and cross-section, and as straight, as is reasonably practicable.

19.3.2. All tracks, vehicles, mechanical and electrical gear, ropes and appliances should be:

- (a) of proper design, good construction, suitable material, adequate strength and free from patent defect;
- (b) regularly inspected; and
- (c) maintained in an efficient and safe condition.

19.3.3. (1) The code of signals for mechanical haulage operations should be specified by the mine manager unless a uniform code for all mines in the same district has been specified by the competent authority.

(2) The code to be used along each haulage system should be posted at the ends of each system, at all connecting roadways and at all engine houses.

19.3.4. At all places where vehicles are coupled or uncoupled, there should be at least 60 centimetres (approximately 24 inches) clear space:

- (a) between the vehicles and the side of the road; and
- (b) where there are two or more parallel lines or rails between the vehicles.

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19.3.5. (1) Where haulage and travelling may occur simultaneously, there should be separate travelling ways or regularly spaced places of refuge.

(2) If the gradient of the travelling way exceeds 1:12, haulage and travelling should take place simultaneously only where there is no danger from rolling vehicles or material.

(3) National laws or regulations should specify that refuges should:

- (a) be of appropriate dimensions;
- (b) be made readily visible; and
- (c) be kept clean and unobstructed.

19.3.6. Except where national laws or regulations otherwise permit, suitable and sufficient general lighting should be provided as specified in section 22.3 at:

- (a) all sidings, landings, pass-bys and junctions; and
- (b) all places where vehicles are being coupled or uncoupled, except within 100 metres (approximately 320 feet) of the working face.

19.3.7. Every haulage road should be kept clear, as far as possible, of pieces of coal, rock and other obstructions.

19.3.8. Riding on vehicles or their attachments without the authorization of a supervisory official should be prohibited.

19.3.9. Where practicable, places where vehicles are coupled and uncoupled should not be on a gradient.

19.3.10. (1) As far as practicable, vehicles should be provided with parking brakes.

(2) Sufficient and suitable devices should be provided by the management and should be used for the purpose of controlling

vehicles in motion and holding vehicles while they are being coupled or uncoupled.

19.3.11. As far as practicable, vehicles should be equipped with buffers that project beyond the ends to a distance of at least 10 centimetres (approximately 4 inches).

19.3.12. Arrangements should be made so that vehicles can be coupled or uncoupled with safety.

19.3.13. Except at landings and loading places and during shunting, vehicles that are moved together should be coupled.

19.3.14. (1) On all haulage roads, adequate precautions should be taken to prevent vehicles running away.

(2) As far as practicable, all runaway protection devices should be designed to assume automatically the position in which they are operative.

19.3.15. (1) In mechanical haulage roads, re-railing devices should be provided where practicable and where the risk of derailling exists.

(2) Derailed vehicles should not be re-railed by hand until the haulage engine or the rope has been stopped.

(3) Where re-railing takes place on inclines, proper provision should be made to prevent vehicles running away.

### 19.4. Hand haulage

19.4.1. (1) The manager of every mine should specify the rules for the safe conduct of operation on all hand haulage roads.

(2) These rules should, in particular, specify that:

- (a) no person, when moving a vehicle by hand down an incline (the gradient of which should be stated in the rules) should go down in front of the vehicle;

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- (b) when a person cannot by his/her own strength control a vehicle from behind, a device should be provided to enable him/her to maintain control from behind the vehicle;
- (c) when workers have to push vehicles in low places, suitable protective hand grips should be provided on the vehicles; and
- (d) hand haulage of vehicles in close succession should be prohibited.

(3) These rules should also specify:

- (a) the conditions under which riding on vehicles is authorized; and
- (b) the means by which supplies should be transported from the end of the haulage track to the working face or place.

### **19.5. Mechanical haulage: General provisions**

19.5.1. National laws or regulations should specify the conditions under which haulage by locomotive is permitted.

19.5.2. Every locomotive used in a mine should be provided with:

- (a) brakes which can be applied by the driver by direct mechanical action, whether or not any other device for applying them is fitted;
- (b) means for applying sand to the rails;
- (c) means for giving adequate audible warnings;
- (d) a suitable portable fire extinguisher;
- (e) a seat for the driver;
- (f) controls so placed that the driver can simultaneously operate them and see ahead without leaning out of the locomotive;
- (g) a portable lamp; and
- (h) a suitable dead-man control switch.

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19.5.3. Every locomotive used in a coalmine should be provided with a combined speed and distance indicator unless it is of a size which is exempt by national laws or regulations.

19.5.4. Every locomotive should be provided with a headlight with an effective range of at least 60 metres (approximately 200 feet).

19.5.5. Locomotive-hauled sets should carry a conspicuous red warning light at the rear of the last vehicle.

19.5.6. Petrol locomotives and petrol engines in general should not be permitted underground.

19.5.7. If diesel locomotives are used in mines, they should be of a type approved by, or conform to specifications set out by, the competent authority.

19.5.8. (1) National laws or regulations should control the use of electric locomotive haulage.

(2) Electric locomotives should be of types approved by or conform to specifications set out by the competent authority.

19.5.9. No locomotive should be taken into use or kept in use if any serious defect of any kind is noticed.

19.5.10. Every locomotive and each of its accessories should, as far as practicable, be constructed of non-flammable material, and any flammable material included therein should be shrouded with a substantial metallic covering, except where exempted by the competent authority.

19.5.11. In the case of haulage with a rope and stationary engine, proper means should be provided for signalling to the engine-man from a sufficient number of points in the road.

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19.5.12. Tracks should be constructed of rails of adequate section and be properly laid as specified in the manager's transport rules.

19.5.13. (1) The frames of pulleys, sheaves and rollers on rope haulages should be made of non-flammable material.

(2) All pulleys, sheaves and rollers should be securely fixed.

(3) Pulleys, sheaves and rollers that alter the direction of the rope should be securely fenced and otherwise rendered safe.

19.5.14. On main- and tail-rope haulages, the coupling and uncoupling of vehicles in motion should be prohibited.

19.5.15. (1) No person should operate any locomotive or trackless vehicle unless appointed to do so by the manager of the mine.

(2) Such appointed drivers should have been trained in the use of the type of vehicle in question and, in particular, in such emergency procedures as skid control.

(3) Each appointed driver should be provided with a copy of the transport rules and be thoroughly familiar with their contents, and in particular the routes to which he/she is assigned.

## **19.6. Trolley locomotive haulage**

19.6.1. National laws or regulations should state the maximum percentage of methane in the general body of air and the quantity of air which is permitted in roads along which trolley wire is located and locomotives or other trolley equipment are used.

19.6.2. Trolley wires and trolley feeder wires should be provided with cut-out switches at appropriate intervals, which should not exceed 610 metres (approximately 2,000 feet), and near the beginning of all branch lines.

19.6.3. Trolley wires and trolley feeder wires should be provided with over-current protection.

19.6.4. Trolley wires and trolley feeder wires should be located only in intake ventilation.

19.6.5. Trolley wires, trolley feeder wires and bare signal wires should be adequately insulated where they pass through doors, ventilation controls, all points where persons are required to work or pass regularly under the wires, at stations and locations where persons board or leave person-riding trains and where they cross other power wires and cables.

19.6.6. Trolley wires and trolley feeder wires lower than 2 metres (approximately 6.5 feet) in height should be adequately guarded:

- (a) at all points where persons are required to work or pass regularly under the wires;
- (b) on both sides of all doors;
- (c) at stations where persons board or leave person-riding trains; and
- (d) by temporary guards where any persons are required to work in the vicinity of the trolley or trolley feeder wires.

19.6.7. National laws or regulations should specify:

- (a) the maximum voltage, the character of the current and the electrotechnical details of the installation; and
- (b) the minimum height of the trolley wire above the top of the rails.

19.6.8. Conspicuous light signals should be placed at shunting places, crossings and approaches to show when the trolley wire is live.

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19.6.9. For the whole length of the trolley wire, the roadway should be adequately supported to prevent falls or deformation that might result in a reduction of the height of the trolley wire above the top of the rails exceeding 10 per cent of the normal height.

### **19.7. Storage-battery locomotives and battery equipment**

19.7.1. National laws or regulations should contain provisions relating to the safe construction, ventilation and use of batteries for storage-battery locomotives, mine scoops and other battery equipment.

19.7.2. Batteries should not be charged or changed below ground except at a charging station arranged in relation to the ventilation in such a way that:

- (a) the charging apparatus is on the intake side of the battery racks;
- (b) the air passes from the battery racks directly into an airway and does not subsequently ventilate a working face; and
- (c) airway entries of restricted size are positioned close to roof level.

19.7.3. Battery charging stations should be:

- (a) housed in non-combustible structures or areas; and
- (b) equipped with a fire detection and a fire suppression system as defined in section 9.4, which would activate an audible and visible alarm at the battery charging station and at a control room from where a suitable response could be coordinated.

19.7.4. Battery charging stations should be designed to prevent the spilling of water or electrolyte; any person spilling water or electrolyte on a battery in a charging station should forthwith remove it or cause it to be removed.

19.7.5. No lamp or light, other than one which is approved by the competent authority, should be used within 10 metres (approximately 30 feet) of any charging station.

19.7.6. A notice containing the requirements of paragraphs 19.7.2, 19.7.3, 19.7.4 and 19.7.5 should be kept posted in a readily visible manner at each charging station.

### 19.8. Diesel vehicles, including locomotives and trackless vehicles

19.8.1. (1) National laws or regulations should specify:

- (a) the maximum concentration of carbon monoxide and oxides of nitrogen, particularly nitrogen dioxide, and diesel particulate matter permitted in exhaust emitted by diesel vehicles; this should be reduced to the lowest technologically feasible concentrations;
- (b) the maximum percentage concentration of methane, carbon monoxide and oxides of nitrogen permitted in the general body of air in the roadways where diesel vehicles operate; and
- (c) the frequency and methods of sampling to ensure compliance with subparagraphs 19.8.1(1)(a) and 19.8.1(1)(b).

(2) The results of such sampling should be entered in a register.

19.8.2. Every diesel vehicle should be so constructed that, where technologically feasible:

- (a) no air enters the engine without first being cleaned;
- (b) no exhaust gases are expelled from the vehicle without first being cooled and diluted, which includes the use of catalytic converters;
- (c) no flames or sparks are emitted from the vehicle;
- (d) diesel particulate matter is trapped or filtered to safe levels before exhausting into the mine air; and

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- (e) no external surfaces reach a temperature that could ignite mine gases or coal dust, particularly if they are used at or near coalfaces.

19.8.3. National laws or regulations should require that:

- (a) diesel equipment use clean burning fuels with low sulphur content of 0.05 per cent and a flash point of 38°C (approximately 100°F) or greater;
- (b) diesel fuel storage, transportation and fuelling take place under controlled conditions which suitably consider the associated risks;
- (c) an effective maintenance and inspection programme for all diesel equipment be in place at each mine; and
- (d) all diesel equipment be equipped with an automatic fire suppression device with manual actuators and/or other suitable fire suppression devices.

19.8.4. (1) The manager of every mine should formulate a scheme of systematic maintenance of diesel vehicles.

(2) This scheme should stipulate that:

- (a) a competent person should examine the principal parts of the locomotive or vehicle, in particular flame traps, baffle plates and other safety features, at least each day and should, where necessary, clean, change or repair those parts; and
- (b) every diesel vehicle should be thoroughly examined and tested at intervals not exceeding seven days.

19.8.5. Diesel vehicles, when not in use, should be kept in places which:

- (a) are provided with not less than two means of egress;
- (b) are ventilated by a current of air sufficient to dilute and render harmless all exhaust gases emitted by any engine running

therein, with the return air passing directly into a return airway;

- (c) are constructed of non-flammable material;
- (d) have a floor of smooth concrete provided with suitable drainage to contain oil spillage;
- (e) have an inspection pit or other suitable means for making inspections from below the vehicle; and
- (f) are provided with suitable and sufficient apparatus for combating outbreaks of fire.

19.8.6. (1) No person should replenish any diesel vehicle with fuel oil in any mine except at a place appointed as a filling station.

(2) Every filling station should be:

- (a) provided with not less than two means of egress;
- (b) ventilated by a current of air sufficient to dilute and render harmless all gases emitted therein, with the return air from the station passing directly into a return airway;
- (c) constructed of non-flammable material;
- (d) provided with a floor of smooth concrete surrounded by a sill;
- (e) provided with suitable and sufficient apparatus for combating outbreaks of fire; and
- (f) equipped so as to minimize oil spillage.

19.8.7. Any person spilling oil in a filling station should:

- (a) forthwith clean it up, or cause it to be cleaned up, with a non-flammable absorbent;
- (b) forthwith deposit that absorbent, or cause it to be deposited, in a fireproof receptacle; and
- (c) as soon as practicable take the absorbent, or cause it to be taken, to the surface.

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19.8.8. No person should take any oil from any container in a filling station while any internal combustion engine in the filling station is running.

19.8.9. The transfer of oil to a reserve tank or to a diesel vehicle should be done only by means of apparatus specially provided for that purpose and in accordance with instructions issued by the manager.

19.8.10. The fuel oil should comply with a standard approved by or conform to specifications set out by the competent authority.

19.8.11. (1) The fuel oil should be taken into the mine in sealed metal drums or in tank cars.

(2) The quantity of fuel oil stocked in the mine should not exceed 24 hours' consumption.

19.8.12. Empty containers should be removed from the mine as soon as possible.

19.8.13. In the event of an irregularity in the running or sound of the engine and, in particular, any excessive emission of smoke, any open sparking, any stoppage in the circulation of water or any leakage of fuel, the diesel vehicle should immediately be stopped, taken out of service and examined.

19.8.14. Any defects found to affect the safe use of a diesel vehicle should be remedied before the vehicle is put to further use.

19.8.15. The results of inspections and any irregularities in running should be recorded in a register.

## **19.9. Compressed-air locomotives**

19.9.1. Every day before being taken into use, every compressed-air locomotive should be examined by the driver.

19.9.2. Once every week, the locomotive should be thoroughly examined by a competent person who should enter the results of the examination in a register.

19.9.3. (1) Compressed-air locomotives should be properly maintained in accordance with a scheme formulated by the manager of the mine.

(2) This scheme should specify the parts to be examined or tested, the manner of the examination or tests and the intervals at which such examinations or tests should be carried out.

(3) Where deemed necessary in the interests of safety, the competent authority should state the changes which it requires to be made in the scheme.

19.9.4. The results of the examinations and tests required by paragraph 19.9.2 should be entered in a register.

### 19.10. Conveyors

19.10.1. (1) No conveyor should be installed in a road which does not have the clearances stipulated in the transport rules; such rules should include the elements found in paragraph 19.10.1(2).

(2) In an underground roadway in which a belt conveyor is used:

- (a) the belt conveyor structure should be installed and maintained so as to prevent contact between the belt and any stationary items or materials (excluding those specifically allowed for in the design of the conveyor);
- (b) the roof should be of sufficient height to allow the contour of the maximum load and the largest fragments carried by the conveyor to clear the roof and roof supports;
- (c) the roadway should be of sufficient width to provide a suitable passageway not less than 60 centimetres (approximately 24 inches) on at least one side of the conveyor to facilitate travel, inspection and maintenance;

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- (d) sufficient clearance, free from obstruction, should be provided on each side of the conveyor to allow any spillage of coal to fall clear of the conveyor; and
- (e) a minimum clearance of 30 centimetres (approximately 12 inches) from the floor to the underside of the return belt should be provided (except at the most inbye loading point of the conveyor system if the mine manager establishes that such clearance is impracticable).

19.10.2. No flammable material should be used for support or other purposes within a distance of 10 metres (approximately 33 feet) from the driving unit and associated loop take-up of the conveyor.

19.10.3. The conveyor structure should be supported by non-flammable blocks, be kept clean and, as far as practicable, free from spillage.

19.10.4. (1) All conveyor belts used in coalmines should be anti-static and of the flame and fire-resistant type.

(2) National laws or regulations should specify standards to be considered anti-static and flame- and fire-resistant.

19.10.5. (1) The hydraulic fluid used in the conveyor driving unit, transmission and associated appliances should be of the fire-resistant type.

(2) Where such hydraulic fluid is not already in use, national laws or regulations should specify the date from which it should be used.

19.10.6. (1) Suitable and adequate means of extinguishing outbreaks of fire should be provided along conveyor entries and roads and at the driving unit of every conveyor.

(2) As far as practicable, an automatically operated fire extinguishing system should be installed at drive units, transfer points and associated loop take-ups.

(3) For the purpose of quickly detecting fires, potential explosions and disruptions in the ventilation system, atmospheric monitoring sensors should be installed underground throughout conveyor belt entries to monitor from a secure location on the surface.

(4) The underground sensors should monitor methane, carbon monoxide and air quantity and direction.

(5) The sensor devices should be located strategically throughout the conveyor belt entry to provide an accurate assessment of mine gases, fire gases and air flows.

(6) The monitoring systems should be designed to record constantly the data collected at the sensors and to signal alert and alarms to areas affected underground and on the surface.

(7) Data from the sensors should be constantly monitored on the surface by a responsible person trained on the AMS.

19.10.7. Conveyors should be provided with effective means to stop them from any point along their length.

19.10.8. There should be adequate patrolling of all roadway conveyors while they are in operation.

19.10.9. Dangerous parts of belt conveyors, in particular the driving unit and return end, should be safely fenced and guarded to prevent access to moving parts.

19.10.10. As far as practicable, the driving unit and return end of conveyors should be self-cleaning; otherwise, arrangements should be made for them to be cleaned only when the belt is stopped.

19.10.11. A lock-out system should be incorporated and used when cleaning the drive and return end.

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19.10.12. Where the inclination of any conveyor gives rise to danger from sliding objects, devices should be installed to afford adequate protection against such danger.

19.10.13. Belt conveyor systems should include appropriate protection against slippage and unplanned stoppage of belts.

19.10.14. Suitable precautions should be taken to prevent danger from over-run and run-back during maintenance operations.

19.10.15. Proper arrangements should be made for the anchoring of the return end of all conveyors, which should be independent of face or roof supports.

19.10.16. A belt conveyor used underground should not be operated if any belt fabric material is in contact with the shaft of any idler or pulley.

19.10.17. During each shift that coal is produced, a certified person should examine for hazardous conditions along each belt conveyor haulage-way where a belt conveyor is operated.

### **19.11. Haulage on inclines**

19.11.1. No person should be employed as signaller, brake operator or haulage operator unless they are duly authorized and competent for the work.

19.11.2. Braking appliances and haulage engines should be properly constructed, maintained and operated, and properly fixed in position.

19.11.3. Stop blocks or other similar devices should be provided and maintained:

- (a) at the top of every incline on which vehicles are moved by gravity; and

(b) at every entrance to such an incline by which vehicles are brought to it.

19.11.4. Where there is a risk of a person falling into an incline, adequate protection should be provided.

19.11.5. A system should be provided for communicating distinct and definite signals between all landings and the ends of the incline.

19.11.6. During interruptions in haulage, and at the end of the shift, the haulage engineman should cut off the power from the engine, apply the brake and secure it against unauthorized use.

19.11.7. (1) When a vehicle is derailed or is stopped by an accident, the necessary steps should be taken by the brake operator or haulage engineman and the incline attendants so that the vehicle cannot run away.

(2) The haulage should not be restarted until all the persons employed in the re-railing and handling of the vehicle are safely out of the way.

### 19.12. Face haulage

19.12.1. The manager's transport rules (see section 19.1) should contain provisions to control the conveyance of minerals and materials along the line of the coalface.

19.12.2. For longwall faces equipped with armoured conveyors and power loaders, these rules should specify:

- (a) the method by which supplies are to be placed on and removed from the armoured conveyor; and
- (b) the method by which parts for replacements, such as conveyor sections, powered-support sections, power-loader sections, cables and hoses, should be transported safely.

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19.12.3. The transport rules should also specify the method by which the armoured conveyor, power loader, supports and other equipment should be installed at or withdrawn from the coalface, and state that:

- (a) the winch used for face haulage should be fitted with a load limitation device;
- (b) all ropes, chains, cappings, linkages and other attachments should be properly designed and maintained for the purposes for which they are used;
- (c) where appropriate, a properly designed track should be laid along the line of the face for the purposes of installing or withdrawing face equipment; and
- (d) a separate system of signalling should be provided from any point between the point of installation withdrawal and the face winch operator.

### **19.13. Travel and transportation of persons on roads and inclines: General provisions**

19.13.1. The employer should arrange for persons to be transported to and from their places of work, or along portions of roadways, particularly where worker safety or fatigue are a concern.

19.13.2. As far as practicable, roads or inclines separate from the haulage roads or inclines should be provided for the passage of persons.

19.13.3. Where the provision of travelling roads separate from haulage roads is not practicable, the haulage operations should be stopped while persons are travelling to and from their work unless special arrangements have been made to ensure the safety of the persons travelling.

19.13.4. The haulage equipment in roads and inclines normally used for mineral haulage should not be used for transporting personnel, unless allowed by national laws or regulations or otherwise by the authority of the manager, if proper safeguards have been put in place to protect those being transported.

19.13.5. It should be the duty of each haulage operator, brake operator and signaller to enforce the requirements of paragraphs 19.13.3 and 19.13.4 in so far as their jurisdiction extends.

19.13.6. National laws or regulations should specify the intervals at which travelling roads, inclines or compartments should be inspected.

19.13.7. Notices should be posted indicating the route to the travelling roads and to the shafts or outlets.

### 19.14. Travel on foot

#### 19.14.1. Travel on level or slightly inclined roads

19.14.1.1. For the purpose of this section “level or slightly inclined roads” means roads with a gradient not exceeding 1:20 (3 degrees).

19.14.1.2. On mechanical haulage roads ordinarily used for travel, a footpath of at least 60 centimetres (approximately 24 inches) width, free of all obstructions, and of sufficient height, should be provided along the whole length of one side.

19.14.1.3. Paragraph 19.14.1.2 should not apply to gate roads in which the haulage speed does not exceed 1.5 metres (approximately 5 feet) per second, but on these roads it should always be possible to travel and pass vehicles safely.

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19.14.1.4. In ropeways where the footpath may be in the middle of the road, persons travelling should be protected against swinging ropes.

### **19.14.2. Travel on inclines**

19.14.2.1. On haulage inclines with a slope exceeding 3 degrees, but not exceeding 25 degrees, the haulage road may be used for travel, subject to rules which should be specified by the competent authority.

19.14.2.2. Inclines used for haulage, and having a gradient of over 25 degrees, should have a safe, separated travelling way for persons unless:

- (a) a special travel incline is available; or
- (b) other effective arrangements have been made to ensure safe travel.

19.14.2.3. The travelling way should have sufficient dimension to allow the passage of persons wearing breathing apparatus and carrying a loaded first-aid stretcher.

19.14.2.4. In travel inclines and other travelling ways with a gradient of from 25 degrees to 45 degrees either:

- (a) steps should be cut or ladders provided; or
- (b) a rope or a fixed bar should be provided to serve as a handrail.

19.14.2.5. Where the slope exceeds 45 degrees, ladders should be provided.

19.14.2.6. If the slope exceeds 70 degrees, rest landings should be provided not more than 10 metres (approximately 32 feet) apart.

19.14.2.7. Haulage inclines should be entered only when the operations require, and the haulage is stopped.

19.14.2.8. Reliable means of communication should be provided so that persons wishing to enter the incline can make their intention known to others concerned.

### 19.15. Mechanical passenger haulage

19.15.1. The transport rules should contain provisions relating to roads used for transporting personnel which include:

- (a) the speed of the personnel vehicle along specified lengths of road;
- (b) the posting of clear signs at places where speed changes are required because of gradient changes or any other cause to show the speed required;
- (c) the number of passengers per vehicle and the number of vehicles per journey;
- (d) the standard of track;
- (e) the procedures to be observed at boarding or alighting stations;
- (f) the importance of strict discipline and following the instructions contained in the transport rules;
- (g) the clearance between vehicles or their passengers and the roof and sides;
- (h) the need adequately to protect passengers in vehicles or locomotives powered by trolley wire systems from contact with live conductors;
- (i) the need to switch off the electricity supply to the trolley wires of vehicles powered by trolley wire systems at all boarding or alighting stations while persons are entering or leaving, and to provide a special light signal to indicate that the trolley wire is dead;

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- (j) the posting of copies of the transport rules where they can be read easily at the entrance to the road to which they apply, and of relevant extracts inside each passenger vehicle; and
- (k) provisions for the enforcement of discipline at all boarding and alighting stations.

19.15.2. Each boarding or alighting station should be adequately illuminated.

19.15.3. No person should enter or leave a moving train.

19.15.4. Bulky tools or materials should not be carried in person-riding vehicles where they may endanger passengers.

19.15.5. (1) The certification and authorization of a locomotive driver should be specifically related to the types of locomotives on which that person has been trained.

(2) Such certification and authorization should not be granted until the driver has been trained to be proficient in all conditions at the mine, including both person-riding and materials haulage.

19.15.6. (1) All trains carrying personnel should be provided with effective means of signalling between the conductor and the driver.

(2) The means provided should preferably be of the fail-safe type.

19.15.7. Each personnel car of a train should be provided with brakes for both normal service and emergency operation.

19.15.8. There should be readily accessible means of applying the brakes manually, and the method of operation should be marked on each carriage.

19.15.9. The emergency brakes should operate automatically in the event of over-speed.

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19.15.10. Where such trains operate on gradients steeper than 1:30 the emergency system should comprise fail-safe track brakes.

19.15.11. Where the requirements of paragraphs 19.15.7 to 19.15.10 are not already applied, national laws or regulations should state a date by which they should be fully observed.

19.15.12. (1) Locomotive brakes should be tested on a clearly identified and marked selected length of track with the locomotive coupled to a trailing load which is equivalent to that of the most difficult braking condition.

(2) An additional test of each complete personnel-carrying train should be made to verify the operation of the carriage brakes.

19.15.13. New personnel-carrying vehicles should be designed to give maximum protection to the passengers.

19.15.14. As far as practicable, retractable energy-absorbing arrestors should be installed.

19.15.15. (1) Locomotive haulage systems should be designed to ensure that suitable pass-by arrangements are provided to permit trains to be hauled from the front.

(2) Personnel-boarding stations should be established on relatively level terrain.

19.15.16. In so far as they are practicable, the provisions of paragraphs 19.15.6 to 19.15.14 should also apply to rope-hauled personnel trains.

### 19.16. Conveyors transporting persons

19.16.1. The transport rules should establish provisions for each length of roadway where riding is permitted.

19.16.2. Such transport rules should specify:

(a) the maximum gradient along which riding is permitted;

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- (b) the speed of the conveyor belt, having regard to the gradient;
- (c) the specific conditions under which persons may travel while minerals or materials are being conveyed;
- (d) the minimum clearances between the belt conveyor and the roof, and between the belt conveyor and the nearest side of the road;
- (e) the spacing of persons along the belt when person-riding is in progress;
- (f) the construction of boarding and alighting stations to ensure the safety of the persons using the system;
- (g) the provision of an efficient system enabling the conveyor to be stopped at any point along its length;
- (h) the provision of adequate general lighting at all boarding and alighting stations and, where practicable, along the whole length of the conveyor where persons ride;
- (i) the provision of illuminated notices which warn persons of their approach to the alighting stations and of any possible hazards which may be present on the length of road along which persons ride;
- (j) the provision of a safety device which stops the conveyor automatically when persons fail to dismount from the conveyor at an alighting station; and
- (k) the halting of any other mechanical haulage equipment located in the same roadway where person-riding on conveyors is taking place, except in circumstances which should be specified by the competent authority.

### 19.16.3. Belt conveyors should:

- (a) be stopped while persons are loading and unloading, and have telephone communications at the loading and unloading sites; if not feasible, measures must be taken to ensure the safety of

persons boarding, being transported and alighting on belt conveyors;

- (b) have a minimum of 45 centimetres (approximately 19 inches) overhead clearance and 60 centimetres (approximately 24 inches) travel-way clearance on both sides of the belt;
- (c) have 1 metre (approximately 40 inches) side clearance where persons board and exit the belt conveyor; and
- (d) have positive action stop controls along the belt that those being transported can activate.

19.16.4. Belt conveyor speeds should not exceed 100 metres (approximately 330 feet) per minute when transporting persons and should not exceed 90 metres (approximately 295 feet) per minute if overhead clearances are less than 60 centimetres (approximately 24 inches).

### 19.17. Railways

19.17.1. (1) National laws or regulations should specify the safety standards in the operation of railways on the surface of the mine premises.

(2) These laws or regulations should include items covering:

- (a) the transport of persons;
- (b) the control of points and signal wires;
- (c) the provision of equipment and safety devices;
- (d) the movement of vehicles;
- (e) restrictions of the passage of persons on foot;
- (f) the provisions of specific crossing points; and
- (g) the minimum age of locomotive drivers.

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19.17.2. The employer should implement rules on railway safety which should be included in national laws or regulations and include the following:

- (a) Railroad cars should be kept under control at all times by the car dropper. Cars should be dropped at a safe rate and in a manner that will ensure that the car dropper maintains a safe position while working and travelling around the cars.
- (b) Railroad cars should not be coupled or uncoupled manually from the inside of curves unless the railroad and cars are so designed to eliminate any hazard from coupling or uncoupling cars from the inside of curves.
- (c) Persons should wear safety belts when dropping railroad cars.
- (d) Railroad cars should not be left on sidetracks unless ample clearance is provided for traffic on adjacent tracks.
- (e) Unless held effectively by brakes, parked railroad cars should be blocked securely.
- (f) Railroad cars and all trucks should be trimmed properly when they have been loaded higher than the confines of their cargo space.
- (g) Roadbeds, rails, joints, switches, frogs and other elements on railroads should be designed, installed and maintained in a safe manner consistent with the speed and type of haulage.
- (h) Where practicable, a minimum of 75 centimetres' (approximately 30 inches) continuous clearance from the farthest projection of moving railway equipment should be provided on at least one side of the tracks.
- (i) All places where it is not possible to provide 75 centimetres' (approximately 30 inches) clearance should be marked conspicuously.

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- (j) Track guardrails, lead rails and frogs should be protected or blocked so as to prevent a person's foot from becoming wedged.
- (k) Positive-acting means should be installed wherever necessary to protect persons from runaway or moving railway equipment.

## 20. Support of roof and walls

Where national laws, regulations and standards do not contain prescription or contain ineffective or outdated prescription as to support of roof and walls, this chapter provides guidance. The provisions outlined in this chapter should be used in conjunction with the proper application of a hazard identification, risk assessment and control process.

### 20.1. Duty to secure safety of each working place

20.1.1. (1) It should be the duty of the manager of every mine to take such steps to control movement and maintain the stability of the strata in the mine and support the roof and sides as may be necessary to keep each working place secure.

(2) The roof, face and sides (ribs) of areas where persons work or travel should be supported or otherwise controlled to protect persons from hazards relating to falls of the roof, face or ribs and coal or rock outbursts.

20.1.2. In order to maintain stability of the ground, the employer should take all appropriate measures to:

- (a) monitor and control the movement of strata; and
- (b) as may be necessary, provide support of the roof, sides and floor of the mine workings, except for those areas where the mining methods selected allow for the controlled collapse of the ground.

20.1.3. It should be the duty of the manager of every mine to ensure that he/she is at all times in possession of all information necessary for him/her to keep each working place secure.

## 20.2. Support plan and rules

20.2.1. (1) National laws or regulations should require, and each employer should develop, a mine roof and side (rib) control plan that would require approval by the competent authority.

(2) Each support plan should be suitable to the prevailing geological conditions and mining system to be used at the mine and be subject to revision with changing conditions.

(3) The employer should obtain the services of professional ground control specialists to assist in the development of the plan and assess the following:

- (a) the thickness and type of overburden overlying the coal seam to be mined and surface conditions including bodies of water, streams or rivers;
- (b) slips or faults in the seam or strata above or below the seam to be mined, and previously mined seams above, below or adjacent to the seam to be mined that could impact the mining process;
- (c) stresses that will occur on coal pillars, mine floors, coalfaces, gate-roads, roadways and other entries, including those used for ventilation of the mine, with the type and size of pillar and entry designs and methods of coal extraction that will be used;
- (d) evaluation of the different types and methods of roof control that are available to determine the optimum support plan throughout the mine and loads to be placed on pillars, sides and faces to prevent failures or outbursts; and
- (e) a specific layout of the roof and side support to be used in all of the mining phases.

(4) Each roof and side control plan should specify the supports to be used throughout the mine and include: spacing of all supports; roof bolt diameter, type (including point anchoring or

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resin or combination bolts), anchorage method and depths; rated capacity of post, steel, arch type or other roof supports used; sizes and layout of cribbing sets, concrete cans and other such supports; roof and side straps, cables, mesh planks or timbers; and specifications on roof support systems such as truss bolting, or combination supports such as wood posts, steel sets and roof bolts installed in the same area.

(5) The roof and side control plan should identify the type and show the thickness of each stratum up to and including the main roof above the coal bed and at least 3 metres (approximately 10 feet) below the coal bed, and the maximum cover in the areas being mined.

(6) The planned width of openings, size of pillars, methods of pillar recovery, sequence of mining pillars, longwall support systems and specific heading/face supports should be included in the plans.

(7) Specifications and certifications of any mobile roof supports used in the mine should be included in the plan, and of automated temporary roof support systems (ATRS), which should be installed on roof bolting machines, with support jacks capable of holding the mine roof.

(8) Procedures for the recovery of roof support materials and for supporting the mine roof where falls of roof occur should be contained in the plan.

(9) Roof support materials and methods used in longwall tailgate entries to maintain open travel and proper ventilation should be specified in the plan, and any other control measures that competent authorities deem necessary for safety.

(10) The additional personal protective equipment, including head, face and body protection for persons working in areas susceptible to rock and coal outbursts, should be included in the plan.

20.2.2. The method of mining should not expose any person to hazards caused by excessive widths of rooms, cross-cuts and entries, or faulty pillar recovery methods. Pillar dimensions should be compatible with effective control of the roof, face and ribs, and coal or rock bursts.

20.2.3. A sightline or other method of directional control should be used to maintain the projected direction of mining in entries, rooms, cross-cuts and pillar splits.

20.2.4. A sidecut should be started only from an area that is supported in accordance with the roof and side control plan.

20.2.5. A working face should not be mined through into an unsupported area of active workings, except when the unsupported area is inaccessible.

20.2.6. Additional roof support should be installed where:

- (1) the width of the opening specified in the roof and side control plan is exceeded by more than 30 centimetres (approximately 12 inches); and
- (2) the distance over which the excessive width exists is more than 1.5 metres (approximately 5 feet).

20.2.7. It should be the duty of the manager of every mine to formulate support rules which should be subject to the approval of the competent authority and be included in the roof and side control plans. The support rules should specify, for each working place, the maximum intervals between:

- (a) supports on roadways;
- (b) each row of props, roof bolts or other supports at the face;
- (c) adjacent props, roof bolts or other supports in the same row;
- (d) the last row of supports and the face;
- (e) powered supports;

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- (f) holing props or sprags;
- (g) shields; and
- (h) packs.

20.2.8. (1) The support rules should clearly state that the specified intervals are maximum distance and that, where additional supports appear to be needed, it should be the duty of those engaged in that place to set them or, if such persons are not competent to do this, to report to the supervisory official.

(2) Support rules should include high rockfall risk areas following consultations and evaluations by competent mining engineering practitioners.

20.2.9. At every place where machinery is used for cutting, conveying or loading coal, the system of support should require cross supports (bars) to be set above every prop that the support rules require to be set.

20.2.10. (1) Where armoured conveyors are used on the coal-face, the props, bars and powered supports should be of an approved type.

(2) The competent authority should determine the approval standards for these supports.

20.2.11. (1) Support rules for each mine should include such plans, sections and diagrams as to make them readily understood by those required to carry them out.

(2) Copies of the support rules relative to each working place should be posted where they can be easily seen at a conspicuous place at the mine and of the entrances to the district/section to which they apply.

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20.2.12. (1) Where withdrawal of support is required, it should be done in accordance with the method to be specified in the support rules.

(2) The procedure should cover the use of the appropriate tools and safety devices, the setting of extra supports to control the collapse of roof from which supports are being withdrawn, and the safe positioning of those persons engaged in the operation.

(3) Such persons should be competent in this type of work.

20.2.13. In thick or steeply inclined seams, holing props or sprags should not be removed except in accordance with the requirements of the support rules.

### 20.3. Setting of supports

20.3.1. It should be the duty of each employer to provide suitable roof support material of adequate strength and in sufficient quantity that is readily available for use.

20.3.2. (1) Every prop set to support the roof or sides of working faces or roadways should be set securely and on a proper foundation.

(2) Whenever such props become broken or otherwise unstable, they should be replaced forthwith.

(3) If this cannot be done, it should be immediately reported to the supervisory official.

20.3.3. All chocks forming part of a system of support should be built on a proper foundation and made tight to the roof over their whole area.

20.3.4. All packs forming part of a system of support should, as far as practicable, be made tight to the roof over their whole area.

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20.3.5. (1) All roadway supports should be securely set so as to maintain maximum stability.

(2) Where practicable, they should be fixed by ties or struts to the neighbouring support.

(3) Cavities above the supports should be filled in so far as practicable.

20.3.6. Supervisory officials and workers concerned should examine and test the roof, sides and supports as often as is necessary or as required by national laws or regulations, to ensure their safety, and particularly before work is resumed after an interruption.

20.3.7. (1) In inclined seams, the supporting props or chocks should be set to ensure maximum support having regard to the inclination of the seam or road and probable strata movement.

(2) Where necessary, such supports should be reinforced to prevent displacement.

20.3.8. (1) Overhanging coal or sides should be taken down.

(2) Where this is not practicable, suitable sprags or other means of support should be set.

20.3.9. A person using roof bolts to form part of a system of support in a mine should ensure that the roof bolts are securely fixed in place.

### **20.4. Powered supports/longwall shields: General provisions**

20.4.1. It should be the duty of the employer to ensure that powered support is of adequate strength and designed in accordance with appropriate standards.

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20.4.2. Where necessary, the competent authority, on safety and health grounds, should specify appropriate standards for powered support.

20.4.3. Where, by reason of any irregularity in the roof, floor or sides, the powered supports are ineffective in ensuring safety, and, notwithstanding section 20.2, the support rules should make provision for the use of conventional supports until such time as the conditions allow normal use of the powered supports.

20.4.4. (1) Any person whose duties include the setting of powered supports should ensure that they are set securely.

(2) When it appears that a powered support is defective, it should be reported forthwith to the supervisory official.

20.4.5. It should be the duty of a supervisory official who becomes aware of a defective powered support, to have it repaired as soon as possible, and to ensure that the roof at that place is effectively supported.

20.4.6. The provisions of the support rules relative to powered-support faces should specify the intervals between adjacent supports and should require that supports be advanced as soon as practicable after a web of coal of stated thickness has been taken by the power loader, so as to ensure that the area of unsupported newly exposed roof is kept to a minimum.

20.4.7. (1) Persons should not normally work on the face side of an armoured face conveyor.

(2) However, provisions should be included in the manager's support rules for the support of roof and sides during any period it becomes necessary for persons to work on the face side of an armoured face conveyor for whatever reason.

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20.4.8. The system of work should be so organized and the equipment provided so designed and used that the need for persons to cross to the face side of the armoured conveyor is minimized.

### **20.5. Installation and withdrawal of powered supports**

20.5.1. (1) In every mine where powered supports are used, it should be the duty of the manager to prepare a plan for the installation of powered supports and a plan for their withdrawal and transport. This plan should be a part of the roof and side control plan and should be reviewed and approved, with any necessary amendments, by the competent authority before implementation.

(2) The plan for the installation of powered supports should cover how the affected areas will be safely ventilated, as addressed in Chapter 21, and:

- (a) the method of transportation of the powered supports from the surface to the coalface where they are to be used, with special emphasis on the correct use of the safe-handling and lifting points;
- (b) the provision of suitable vehicles, purpose-built where necessary, for the transport of supports;
- (c) the provision of a suitable winch equipped with load-limitation facilities for hauling the powered supports along the face line;
- (d) the provision of haulage equipment of ample size, strength and design; and
- (e) the method of supporting the face line during the installation of the powered supports.

(3) The plan for the withdrawal and transportation of powered supports should cover how the affected areas will be safely ventilated, as addressed in Chapter 21, and:

## **Support of roof and walls**

- (a) the method of support of the face line during the withdrawal operation;
- (b) the method of transportation of the powered supports from the face line to their new site; and
- (c) additional provisions similar to those of subparagraphs 20.5.1(2)(b) to 20.5.1(2)(d).

### **20.6. Provision of roof canopies or cabs**

20.6.1. Diesel-, battery-, or electrically powered, self-propelling machinery, including shuttle cars, used at or in the vicinity of the coalface, should be provided with substantially constructed roof canopies or cabs which give adequate protection against falls of ground from the roof or sides.

### **20.7. Precautions where falls of roof or side have occurred**

20.7.1. (1) Where any fall of roof or side breaks or otherwise renders ineffective any support at any place where any person has to pass or work, it should be the duty of the supervisory official to ensure that any roof or side exposed or adjacent thereto is, if necessary, dressed and secured by supports.

(2) Such work should be done before any work of clearing debris is begun, except such work as is necessary for the setting of supports.

20.7.2. Where the above provisions cannot be observed, the mine manager should ensure that the area is barricaded from entry to prevent inadvertent access and no persons should pass or work be done at that place except under the supervision of a supervisory official.

## 21. Ventilation

Where national laws, regulations and standards do not contain prescription or contain ineffective or outdated prescription as to ventilation, this chapter provides guidance. The provisions outlined in this chapter should be used in conjunction with the proper application of a hazard identification, risk assessment and control process.

### 21.1. General provisions

21.1.1. The employer should take all necessary measures to ensure adequate ventilation for all underground workings to which access is permitted, and should:

- (a) take measures and precautions appropriate to the nature of a mine operation to prevent, detect and combat the start and spread of mine fires and explosions; and
- (b) ensure when there is serious danger to the safety and health of workers, that operations are stopped and workers are evacuated to a safe location.

21.1.2. All underground mine workings to which workers have access, and other areas as necessary, should be constantly ventilated in an appropriate manner to maintain an atmosphere:

- (a) in which the risk of ignitions and explosions from methane and other explosive gases is eliminated or minimized;
- (b) to provide adequate oxygen for persons to breathe and render harmless gases or agents that may exist in the mine atmosphere;
- (c) where airborne dusts are controlled and maintained at levels that will not be harmful to workers as specified in Chapter 8;

- (d) in which working conditions are adequate, having regard to the working method being used and physical demands placed on workers;
- (e) to keep the mine workings safe for persons to work in or pass through; and
- (f) that is in compliance with national standards on dust, gases, radiation and climatic conditions; where national standards do not exist, the employer should give consideration to international standards.

21.1.3. A place should not be considered safe to work in or pass through if the air contains either less than 19.5 per cent of oxygen, or more than the percentages of methane (as specified in section 21.9) and carbon dioxide specified in national laws or regulations.

21.1.4. National laws or regulations should also specify the maximum and minimum temperatures and other environmental conditions, as appropriate, under which work is allowed to proceed in any part of the mine.

21.1.5. Where there is evidence that the ventilation of any part of a mine needs to be improved, the mine manager should make such improvements and the competent authority should insist on such improvements.

21.1.6. (1) All airways should be of adequate dimensions for the quantity of air they are designed to pass.

(2) They should be systematically inspected and maintained in good condition.

21.1.7. (1) Under the responsibility of the mine manager, an authorized person should be appointed to take charge of the ventilation of a mine.

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(2) In cases where the ventilation circuits of two or more mines are joined, one authorized person should be designated as being responsible in so far as the joint circuits may be concerned.

21.1.8. Ventilation furnaces should be prohibited.

21.1.9. (1) Stoppings erected to cross-cuts between main intake and main return airways should be constructed in such a way that they will not be readily destroyed in the event of an explosion or fire.

(2) This provision should also apply to all main air crossings.

21.1.10. Seals erected to isolate ventilated areas from mined-out areas that are no longer ventilated should be designed to withstand explosion forces with a maximum overpressure, and designed to allow water to drain from behind them. Seals containing non-explosive or inertized atmospheres should be built to withstand a static horizontal pressure of at least 1.4 bar (20 pounds per square inch) unless otherwise determined by the competent authority. Where the atmosphere might become explosive, it is recommended that these seals should be built to withstand a static horizontal pressure of at least 3.4 bar (50 pounds per square inch), unless otherwise determined by the competent authority.

21.1.11. (1) Unless national laws or regulations allow otherwise, every road which connects a main intake to a main return or which, as regards any working face, connects the intake and return airways, should be provided with at least two suitable and properly maintained doors to minimize the leakage of air.

(2) Where this is not practicable, other suitable means of minimizing air leakage should be provided.

21.1.12. (1) In any other road where it is necessary to prevent the short circuiting of the air current, there should be provided, and properly maintained, at least two doors.

(2) Where this is not practicable, other suitable means of minimizing air leakage should be provided.

21.1.13. (1) Doors and sheets provided in compliance with the preceding rule should be so spaced that when one door or sheet is open the other can remain closed.

(2) Where this is not practicable, other measures to minimize the leakage of air through them should be taken.

21.1.14. Doors should be designed to prevent them being left open inadvertently.

21.1.15. Any person who opens a door or sheet should ensure that such door or sheet is closed as soon as possible.

21.1.16. All ventilating sheets should be of fire-resistant material.

21.1.17. The use of open light should be prohibited in all underground coalmines.

21.1.18. (1) Where any workings are proceeding towards old workings that may contain accumulations of water, methane, carbon monoxide or toxic gases, the approach to the old workings should be done in accordance with a plan, as identified in section 10.2, prepared by the manager.

(2) A copy of the plan should be sent to the competent authority, which should require approval and amendments as necessary.

21.1.19. A recording barometer should be provided on the surface of each mine.

## 21.2. Mine ventilation plan

21.2.1. (1) National laws or regulations should require each employer to prepare and implement an operating ventilation plan and procedures to ensure a safe system of work and the protection

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of workers. The ventilation plan should be subject to review and approval by the competent authority, with amendments as found necessary, and to review by miners' representatives.

(2) The ventilation plan should include actions to be taken when there is a loss of or insufficient mine ventilation.

21.2.2. It should be the duty of the mine manager to ensure that in every mine there is a ventilation plan, that is kept up to date, which specifies:

- (a) the direction and distribution of the air flow throughout the mine;
- (b) the location of the main doors, air regulators, sealed-off areas, methane drainage systems, any mine fans and booster and auxiliary fans, all air-measuring stations, ventilation controls separating air currents, and air crossings;
- (c) the location of intake, return, haulage, belt conveyor, trolley wire and bleeder air courses;
- (d) the locations where separations of intake and return air courses will be built and maintained;
- (e) the location and air quantities at all working places and coal-faces, and distances the ventilation sheets or tubing will be from the face;
- (f) the volume of air required at the intake to the longwall districts/sections and the velocities of air on a longwall or shortwall face and the locations where the velocities will be measured;
- (g) the locations where fixed area respirable dust samples will be collected and each sampling device will be placed, and the respirable dust control measures used at the dust-generating sources for these locations;
- (h) the methane and dust control systems at underground dumps, crushers, transfer points and haulage ways;

- (i) the air velocity in trolley haulage and conveyor belt entries;
- (j) a description of the bleeder system to be used, including its design and the means for determining effectiveness;
- (k) the locations where measurements of methane and oxygen levels and of air quantities, and tests to determine air movement for proper direction will be made to evaluate the ventilation of non-pillared worked-out areas and the effectiveness of bleeder systems;
- (l) the means for adequately maintaining bleeder entries free of obstructions such as roof falls and standing water;
- (m) the location of ventilation devices such as regulators, stoppings and bleeder connectors used to control air movement through worked-out areas;
- (n) the location and sequence of construction of proposed seals for each worked-out area;
- (o) in mines with a history of spontaneous combustion, a description of the measures that will be used to detect methane, carbon monoxide, and oxygen concentration during and after pillar recovery and in worked-out areas where no pillars have been recovered; and the actions to be taken to protect workers from the hazards associated with spontaneous combustion;
- (p) the location of escape routes to be used during emergencies; and
- (q) any other information as may be required by national laws or regulations or the competent authority.

### 21.3. Air changes in the mine

21.3.1. (1) No change should be made in the general ventilation system except by order of the mine manager, and changes should be directly supervised by a person assigned by the mine manager who is competent in the field of mine ventilation.

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(2) This rule should not apply in a case of emergency, as defined by national laws or regulations or the competent authority, when a supervisory official responsible for the mine may take the necessary immediate action and then report to the mine manager or other senior official.

21.3.2. (1) When major changes in the ventilation system are decided upon, it should be the duty of the mine manager to ensure that a ventilation plan is established which clearly shows the various stages of the change. These should be subject to approval, and amendment if necessary, by the competent authority, and to review by miners' representatives.

(2) The manager should take the necessary steps to ensure that all persons responsible for effecting the change thoroughly understand their duties in this respect. Air changes that could affect the safety or health of persons in the mine should not be made while persons are in the mine, and electric power should be removed from the affected area before air changes are made.

(3) When changes are made in the direction, distribution or division of the air current that affect the air quantity entering or leaving a district, air measurements and methane determinations should be made as soon as practicable after the changes have taken effect.

### **21.4. Ventilation of working districts/sections and working places**

21.4.1. The mine manager should ensure that there is a ventilation plan as identified in paragraphs 21.2.1 and 21.2.2 for each development district/section which:

- (a) has the necessary ventilation controls and devices in place to dilute, render harmless and to carry away flammable, explosive, noxious and harmful gases, dusts, smoke and fumes;

- (b) in the case of longwall mining sufficient ventilation must be in place before longwall coal production operation is allowed to start and special precautions must be taken when the longwall equipment is removed; and
- (c) in the case of room and pillar workings, the maximum length of heading allowed to be driven before cross-cuts are made which provide through ventilation.

21.4.2. (1) Each working district/section and each area where mechanized mining equipment is being installed or removed, should be ventilated by a separate split of intake air directed by overcasts, undercasts or other permanent ventilation controls, except for advancing longwall mining.

(2) When two or more sets of mining equipment are simultaneously engaged in cutting, mining or loading coal or rock from working places within the same working districts/sections, each set of mining equipment should be on a separate split of intake air.

(3) For the purposes of paragraph 21.4.2(2), a set of mining equipment includes a single loading machine, a single continuous mining (cutting) machine, or a single longwall or shortwall mining machine.

21.4.3. (1) Air that has passed through any area that is not examined, or through an area where second mining has been done, should not be used to ventilate any working place.

(2) Air that has passed by any opening of any unsealed area that is not examined should not be used to ventilate any working place.

## 21.5. Mine ventilation fans

21.5.1. (1) National laws or regulations should require each coalmine to be ventilated by one or more main mine fans that are power driven and continuously operated.

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(2) Depending on the size of the mine, and where necessary to ensure a safe system of work and the safety of workers, the employer should ensure that a reserve ventilation fan is available for immediate use.

(3) Laws and regulations should empower the competent authority on grounds of safety and health to require a reserve ventilation fan to be available for immediate use.

21.5.2. The surface ventilating fan should be offset from the nearest side of the mine opening at least 5 metres (approximately 15 feet) and provided with:

- (a) an alternative source of power, independent of the mine power circuits;
- (b) a water gauge;
- (c) either an automatic fan-speed indicator or an automatic ventilation-pressure indicator equipped with a recording device or system;
- (d) an efficient air lock;
- (e) incombustible doors that will automatically close if the fan stops to prevent air reversals, where multiple fans are used;
- (f) a fan drift and fan housing, both of which are fireproof;
- (g) fireproof ducts and pressure-relief devices, such as explosion doors located in line with possible explosion forces;
- (h) devices which enable the current of air to be reversed if approved by the competent authority and regularly tested as specified by the competent authority;
- (i) a monitoring system that would signal an early warning of a fan failure, slowdown or unintended shutdown where it can always be seen and heard and at the surface monitoring location for AMS; and

- (j) such other safety devices as may be prescribed by the competent authority.

21.5.3. (1) An engineer should be in charge of the surface ventilating fan as specified in paragraph 21.5.2. He/she should be responsible for its maintenance and examination at intervals which should be specified in national laws or regulations. A general examination of the mine fan and safety devices should be made each day.

- (2) A record should be kept of such examination.

21.5.4. (1) Every unplanned stoppage of the surface ventilating fans should be reported immediately to the manager or deputy who should take steps to ensure the safety of the persons below ground, including their immediate evacuation and setting up procedures to prevent persons from returning into districts which had been evacuated.

- (2) Unplanned stoppages in excess of 30 minutes should be reported to the competent authority.

## **21.6. Booster fan control**

21.6.1. (1) No fan should be installed below ground unless the manager is satisfied that it is necessary for the proper ventilation of the mine and that such a fan can be installed and operated without detriment to the safety and health of the persons employed in that mine and it is approved by, or conforms to specifications set out by, the competent authority.

- (2) Laws or regulations should establish standards for the use of booster fans regulating use, inspection, monitoring and maintenance.

21.6.2. (1) No fan, other than an auxiliary fan, should be installed underground unless a ventilation survey of every part of the

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mine likely to be affected by the booster fan installation has been carried out by a suitably qualified person.

(2) The aforementioned person should prepare a report which recommends the appropriate type, size, location and safeguards of the proposed fan.

(3) A copy of the report, which should be up to date in relation to the commissioning of the fan, should be sent to the competent authority for approval as part of the mine ventilation plan, which may require amendments to the proposals.

21.6.3. The booster fan should be equipped with safety and operational efficiency monitoring devices which would alert responsible persons on the surface of reduced or loss of ventilation, air reversals, dangerous gases, fires or electrical disruptions.

21.6.4. (1) It should be the duty of the manager of any mine where a booster fan is installed to formulate booster fan rules, which should control the fan's operation subject to the approval of the competent authority, if not covered by national laws or regulations.

(2) Such rules should be contained in the mine ventilation plan and prominently posted at a conspicuous place at the mine and should cover:

- (a) the fireproof construction of the fan housing and of specified lengths of roadway on the intake and return sides of the fan;
- (b) the frequency of regular examinations and the arrangements for reporting any unusual circumstances or occurrences associated with the operation of the fan;
- (c) the arrangements for reporting any significant increase in the methane content of the air passing through the fan, and the action to be taken should the concentration rise to the limit specified by the competent authority, which should not exceed the concentrations contained in section 21.9;

- (d) a description of the monitoring equipment used on the installation;
- (e) the times when the booster fan may be stopped for the purposes of inspection or maintenance, and the action to be taken before, during and upon the restart of the fan;
- (f) the action to be taken in the event of an unplanned stoppage of the fan, including the effect on other booster or auxiliary fans installed in the mine;
- (g) the arrangements for contacting the mine and procedures for notifying the management of that mine of any planned changes in ventilation or any conditions affecting safety where the mine is interconnected to another mine; and
- (h) the names and titles of persons authorized to stop, start or otherwise control the booster fan installation, except that, in an emergency, it should be the duty of any person to take appropriate action in the interests of the safety of the mine.

### 21.7. Auxiliary fan control

21.7.1. (1) Before an auxiliary fan is installed below ground, the manager of the mine should be satisfied that a sufficient quantity of air is reaching the fan to prevent recirculation of air and that it is not unduly polluted by dust, smoke, or noxious or flammable gases and its use has been approved by, or conforms to specifications set out by, the competent authority.

(2) Auxiliary fans should not be used as booster fans.

21.7.2. Only authorized persons should stop, start, or otherwise control the operation of auxiliary fans installed below ground.

21.7.3. (1) Any auxiliary forcing fan should be installed on the intake side, and any exhausting fan should be installed on the return

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side of the place to be ventilated so as to avoid recirculation of air, subject to the approval of the competent authority.

(2) Every auxiliary fan should be connected (grounded) with earth to prevent the accumulation of an electrostatic charge.

(3) To prevent the ignition of coal dust or mine gases including methane, all auxiliary fans used near coalfaces or in locations where air has ventilated a coalface or heading, should have all electrical components sealed off and flameproof to meet “permissible” explosion-proof standards. National laws or regulations should set those standards and, in their absence, internationally accepted explosion-proof, electrical enclosure standards should be followed.

21.7.4. Each auxiliary fan should be equipped with an air duct which should be maintained in good condition and be capable of delivering the specified minimum quantity of air to the face of the working place.

21.7.5. (1) National laws or regulations should, and, in their absence, the mine manager should, specify the minimum quantity of air to be delivered or exhausted at the end of the duct and the intervals at which the air quantity should be measured to assure proper ventilation and to prevent air recirculation.

(2) Air measurements should be conducted at least each shift and also following changes in the air flow.

21.7.6. A record should be kept of the aforementioned air-quantity measurements, and it should be the duty of the person making the measurements to comment in writing on any significant trend in the recorded data.

21.7.7. (1) Before auxiliary fans are installed in any section of the mine, the manager should have prepared a plan showing the system of ventilation and the air quantities reaching each auxiliary fan installation.

(2) A copy of the plan, which may require amendments, should be sent in advance to the competent authority for approval.

21.7.8. Where a place is ventilated with an auxiliary fan, no person should stay in that place when the fan is stopped, unless authorized to do so by a supervisory official and approved by the competent authority.

21.7.9. (1) National laws or regulations should establish rules on the approval and use of auxiliary fans. In the absence of such rules, it should be the duty of the manager of any mine where an auxiliary fan is installed to formulate auxiliary fan rules, which should control the operation of the auxiliary fan installation to which they refer.

(2) Such rules should be prominently posted and should specify:

- (a) the auxiliary ventilation system to be used when persons are at work in the heading and when the heading is unoccupied;
- (b) the ventilating equipment to be used;
- (c) the minimum quantity of air to be delivered to the face of the heading when persons are at work and when it is unoccupied;
- (d) the preparation, and posting at the entrance to the heading where it can be explained to the workers engaged in the heading, of a plan showing the changes, if any, which will occur in the system as the work progresses;
- (e) the continuous operation of the fan, except in the case of a planned stoppage for maintenance or inspection;
- (f) the arrangements, and the procedure to be carried out, when an unplanned stoppage of the fan occurs or any unusual circumstances arise concerning the operation of the system;

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- (g) the method and type of fencing to be used when the auxiliary ventilation system fails, and it becomes necessary to temporarily close off the heading;
- (h) the method of recommissioning the system when there has been a stoppage, including the procedure to be adopted for the safe removal of gas which may have accumulated in dangerous quantity in the heading; and
- (i) the specific intervals at which the system must be inspected by a competent person, and any monitoring equipment which may be used in the system.

21.7.10. For the purpose of dust control, or other purposes which are in the interests of safety and health, the competent authority may allow controlled recirculation of air under specified conditions.

### **21.8. Air measurement and methane determination**

21.8.1. (1) National laws or regulations should specify the intervals, places and manner in which air measurements and methane determinations should be taken. These should be carried out in addition to or in conjunction with continuous atmospheric monitoring covered in section 21.12, and machine-mounted methane monitors covered in paragraph 21.11.1.

- (2) The locations for sampling and measurements should include:
  - (a) every main intake airway as near as practicable to the entrance to a shaft or outlet;
  - (b) every split where air leaves the main air current, as near as practicable to the junction;
  - (c) if the split serves a working district/section:
    - (i) a point 50 metres (approximately 160 feet) from the first working place at which the air enters the district/section; and

- (ii) a point 50 metres (approximately 160 feet) from the last working place at which the air leaves the district/section;
- (d) the district/section return airway as near as practicable to the junction with the main return airway;
- (e) coalfaces;
- (f) the last open cross-cut of each set of entries or rooms on each working district/section and areas where mechanized mining equipment is being installed or removed;
- (g) if intake air, used to ventilate active working sections, passes approaches to worked-out areas along intake air courses, or if intake air passes entries used to carry air into worked-out areas:
  - (i) points in the intake air course immediately inbye and outbye each entry to these approaches, that is used to carry air into the worked-out area; and
  - (ii) points immediately inbye the intersections of the intake air course with the entries used to carry air into worked-out areas;
- (h) seals along intake air courses where intake air passes by a seal to ventilate active working sections;
- (i) the intake entries at the intake end of each longwall or short-wall face immediately outbye the face, at each end of the face and across the face;
- (j) at the intake end of any pillar line:
  - (i) if a single split of air is used, the intake entry furthest from the return air course, immediately outbye the first open cross-cut outbye the line of pillars being mined; or
  - (ii) if a split system is used, the intake entries of each split immediately inbye the split point;

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- (k) at the intake end of any pillar line:
  - (i) where a single split of air is used, the intake entry furthest from the return air course immediately outbye the first open cross-cut outbye the line of pillars being mined;
  - or
  - (ii) where a split system is used, the intake entries of each split immediately inbye the split point;
- (l) entries and rooms developed more than two cross-cuts off an intake air course without permanent ventilation controls, where intake air passes through or by these entries or rooms to reach an active working district/section;
- (m) entries and rooms driven more than 6 metres (approximately 20 feet) off an intake air course without a cross-cut and without permanent ventilation controls, where intake air passes through or by these entries or rooms to reach an active working district/section;
- (n) areas where trolley wires or trolley feeder wires are to be energized and conveyor belt entries are to be operated;
- (o) high spots along active intake air courses where methane is likely to accumulate;
- (p) underground electrical installations and compressors if the electrical installations or compressors are or will be energized during the shift; and
- (q) such other points as may be required by the competent authority.

21.8.2. The examinations that include methane testing and air measurements addressed in paragraph 21.8.1 should adhere to a mine inspection system. It should contain the following minimum inspection requirements for underground places at the mine (other than places in production districts/sections):

- (a) inspection by a competent person, at least once each shift, which should be prior to the beginning of each shift, of all places where people are required to work and regularly travel, including roadways, and the locations, testing and measurements identified in paragraph 21.8.1; and
- (b) inspection by a competent person, at least once every seven days, of all safely accessible places which should include the locations, testing and measurements identified in paragraph 21.8.4.

21.8.3. (1) The examinations that include methane testing and air measurements addressed in paragraph 21.8.1 should adhere to the following requirements for working districts/sections:

- (a) at least two hours prior to the beginning of the work shift, at least once during each shift, or more often if necessary for safety;
- (b) at the start of each shift at each working place before electrically operated equipment is energized;
- (c) immediately before equipment is energized, taken into, or operated in a working place; and
- (d) methane tests at 20-minute intervals, or more often if required in the ventilation plan at specific locations, during the operation of equipment in the working place.

(2) These methane tests should be made at the face from under permanent roof support, using extendable probes or other acceptable means, and other locations as necessary. When longwall or shortwall mining systems are used, these methane tests should be made at the shearer, the plow or the cutting head. When mining has been stopped for more than 20 minutes, methane tests should be conducted prior to the start up of equipment.

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21.8.4. (1) Examinations which include methane testing and air measurements addressed in paragraph 21.8.1 should be made at intervals of not more than seven days.

(2) Unsealed worked-out areas where no pillars have been recovered should be examined by travelling to the area of deepest penetration, measuring methane and oxygen concentrations and air quantities, and making tests to determine if the air is moving in the proper direction in the area. The locations of measurement points of tests and measurements should be included in the mine ventilation plan and be in adequate numbers and locations to assure ventilation and air quality in the area. Air-quantity measurements should also be made where the air enters and leaves the worked-out area. An alternative method of evaluating the ventilation of the area may be approved by the competent authority.

(3) The effectiveness of bleeder systems should be evaluated by:

- (i) measuring methane and oxygen concentrations and air quantity and determining if the air is moving in its proper direction where air enters the worked-out area;
- (ii) measuring methane and oxygen concentrations and air quantity and a test to determine if the air is moving in the proper direction should be made immediately before the air enters a return split of air; and
- (iii) travelling at least one entry of each set of bleeder entries used as part of a bleeder system in its entirety, measuring methane and oxygen concentrations and air quantities and determining if the air is moving in the proper direction, should be made at the measurement point locations specified in the mine ventilation plan to determine the effectiveness of the bleeder system.

(4) The volume of air entering the main intakes and in each intake split should be determined.

(5) The volume of air should be determined and methane should be tested for in the last open cross-cut in any pair or set of developing entries or rooms, in the return of each split of air immediately before it enters the main returns, and where the air leaves the main returns.

(6) It should be tested for methane in the return entry nearest each set of seals immediately after the air passes the seals.

21.8.5. The specific results of the aforementioned air measurements and methane determinations in paragraphs 21.8.1 to 21.8.4 should be entered in a secure record book specially kept for this purpose by the competent person making the measurements and determinations:

- (1) This person should comment upon and draw attention to any significant trends in the recorded data.
- (2) Notwithstanding national laws or regulations, where the methane content of the mine air exceeds 1 per cent at any measuring place, air samples and air measurements should be taken at least daily at that place.

21.8.6. When methane concentrations are found to exceed those specified, national laws or regulations should state which levels are reportable to the competent authority and indicate the details that should be submitted.

21.8.7. All detection and ventilation measures should be carried out by persons who have been trained and certified as competent, who should pay particular attention to places in a mine where the gas hazard tends to be greatest.

### 21.9. Actions and withdrawal of persons from a mine or part of a mine endangered by methane

21.9.1. National laws or regulations should establish standards for actions to be taken and the withdrawal of persons when methane

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reaches or exceeds certain levels. Except in the performance of work essential for the safety of the mine, or in the case of the rescue of persons in imminent danger, it should be prohibited to work, travel or remain in any part of a mine where, in the general body of the air, methane is detected at a concentration exceeding a figure to be specified in the national laws or regulations; this figure should not exceed 2 per cent.

21.9.2. For the safety of workers, the following procedures should be implemented regarding methane concentrations unless other standards are established by national laws or regulations or the competent authority:

- (1) When 1 per cent or more of methane is present in a working place or an intake air course, including an air course in which a belt conveyor is located, or in an area where mechanized mining equipment is being installed or removed:
  - (i) except intrinsically safe AMS, electrically powered equipment in the affected area shall be de-energized, and other mechanized equipment shall be shut off;
  - (ii) changes or adjustments should be made at once to the ventilation system to reduce the concentration of methane to less than 1 per cent; and
  - (iii) no other work should be permitted in the affected area until the methane concentration is less than 1 per cent.
- (2) When 1.5 per cent or more of methane is present in a working place or an intake air course, including an air course in which a belt conveyor is located, or in an area where mechanized mining equipment is being installed or removed:
  - (i) everyone, except those persons permitted by national laws or regulations and those necessary to correct the conditions, should be withdrawn from the affected area; and

- (ii) except for intrinsically safe AMS, electrically powered equipment in the affected area should be disconnected at the power source.
- (3) When 1 per cent or more of methane is present in a return air split between the last working place on a working section and where that split of air meets another split of air, or the location at which the split is used to ventilate seals or worked-out areas, changes or adjustments should be made at once to the ventilation system to reduce the concentration of methane in the return air to less than 1 per cent.
- (4) When 1.5 per cent or more methane is present in a return air split between the last working place on a working section and where that split of air meets another split of air, or the location where the split is used to ventilate seals or worked-out areas:
- (i) everyone, except those persons permitted by national laws or regulations and those necessary to correct the conditions, should be withdrawn from the affected area;
  - (ii) other than intrinsically safe AMS, equipment in the affected area should be de-energized, electric power disconnected at the power source, and other mechanized equipment shut off;
  - (iii) no other work should be permitted in the affected area until the methane concentration in the return air is less than 1 per cent; and
  - (iv) stone dust should be continuously applied with a mechanical duster to the return air course during coal production at a location in the air course immediately outbye the most inbye monitoring point.
- (5) When 1.5 per cent or more methane is present in a return air split between a point in the return opposite the section loading point and where that split of air meets another split of air or

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where the split of air is used to ventilate seals or worked-out areas:

- (i) changes or adjustments should be made at once to the ventilation system to reduce the concentration of methane in the return air to below 1.5 per cent;
  - (ii) everyone, except those persons permitted by national laws or regulations and those necessary to correct the conditions, should be withdrawn from the affected area;
  - (iii) except for intrinsically safe AMS, equipment in the affected area should be de-energized, electric power disconnected at the power source, and other mechanized equipment shut off; and
  - (iv) no other work shall be permitted in the affected area until the methane concentration in the return air is less than 1.5 per cent.
- (6) The concentration of methane in a bleeder split of air immediately before the air in the split joins another split of air, or in a return air course other than as described in subparagraph 21.9.2(3), should not exceed 2 per cent.

21.9.3. If, in the case of rescue, imminent danger or essential work for dealing with the danger, it is necessary to work in places where there exists a dangerous accumulation of methane, the work should be done only:

- (a) under the direct supervision of the manager or his or her deputy;
- (b) by specially trained miners; and
- (c) under the supervision and in the continuous presence of a specially appointed supervisory official.

21.9.4. The competent authority should establish standards on excessive methane levels that require the manager or other senior

official of the mine to notify the competent authority so that appropriate action can be taken.

21.9.5. (1) Places which have been evacuated due to methane should be effectively fenced.

(2) Temporary idle workings also should be fenced.

21.9.6. No person should enter a fenced area except as provided by national laws or regulations and in the continuous presence of a specially appointed supervisory official.

21.9.7. Where persons have been withdrawn, general work should not resume except in accordance with procedures specified by the mine manager, which should be in accordance with any directives by the competent authority.

#### 21.10. Sudden outbursts of coal, methane or other harmful gases

21.10.1. Where the danger of sudden outbursts of methane or other harmful gases exists, a properly designed plan should be commissioned and carried out in conformity with requirements established by the competent authority.

21.10.2. The plan should:

- (a) identify each potential source of outbursts;
- (b) contain an objective summary of the nature and magnitude of the identified outburst risks;
- (c) set out the measures to be taken to prevent outbursts;
- (d) provide for the identification and maintenance of inrush control zones between the mine workings and each identified potential source of inrush;
- (e) include any special protections for workers and systems of working developed for mining and working in outburst zones;

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- (f) identify the monitoring devices, methods, locations and data analysis to be utilized; and
- (g) be maintained so that the best available knowledge of inrush risk at the mine is at all times in practice.

21.10.3. The plan requirements should stipulate, among other things, that:

- (a) the workings should be so planned that the return air from each working place flows directly into the return airway;
- (b) notwithstanding the requirements of Chapter 25, sufficient and suitable self-contained breathing apparatus should be immediately available at each working place for the use of each person to enable him or her to escape to a place of safety when an outburst of gas or coal occurs, along with other protective equipment;
- (c) automatic warning systems and other means of communication should be installed, which will enable warning messages to be sent to other working places which may be endangered by an outburst of gas in a given area;
- (d) gas-monitoring equipment as described in section 21.12 should be installed in each working place and should sound alarms when the percentage of methane or other noxious gas reaches a predetermined level;
- (e) it should be the duty of the mine manager to take the necessary measures to train all persons in the procedures to be adopted and in the use of the equipment available in places liable to sudden outbursts of gas;
- (f) adequate steps should be taken at the surface to prevent any methane issuing from the mine from igniting; and
- (g) accumulations of methane, large or small, should not be dispersed by blowing compressed air.

**21.11. Methane monitors**

21.11.1. (1) Methane monitors that have been approved by nationally recognized standards and by the competent authority should be installed on all face-cutting machines, continuous miners, longwall face equipment, loading machines and other mechanized equipment used to extract coal or install roof bolts within the working place. The sensing devices of methane monitors should be installed as close to the working face as practicable.

(2) The sensing device for methane monitors on longwall shearing machines should be installed at the return air end of the longwall face. An additional sensing device should also be installed on the longwall shearing machine, downwind and as close to the cutting head as practicable. An alternative location or locations for the sensing device required on the longwall shearing machine may be approved by the competent authority.

(3) Methane monitors should be maintained in permissible and proper operating condition, examined for permissibility and calibrated with a known air-methane mixture at least once a month by a person trained for that purpose, with a record made of the tests and examinations.

(4) When the methane concentration at any methane monitor reaches 1 per cent, the monitor should give a warning signal.

(5) The warning signal device of the monitor should be visible to a person who can de-energize electric equipment or shut down diesel-powered equipment on which the monitor is mounted.

(6) The methane monitor should automatically de-energize electric equipment or shut down diesel-powered equipment on which it is mounted when the methane concentration at any monitor reaches 2 per cent or the monitor is not operating properly.

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21.11.2. National laws or regulations should specify the number of portable methane detectors to be provided in each working district/section of a mine.

21.11.3. Portable methane detectors of a type approved by the competent authority should be used.

21.11.4. The approved portable methane detectors should be calibrated, maintained and tested in a manner specified in the relevant approval.

21.11.5. (1) Arrangements should be made to train sufficient persons to be competent in the correct use of the methane detectors.

(2) Where the methane detector is a flame safety lamp, the competence of the appointed person to recognize actual gas caps as they appear on the lowered flame of the lamp should be tested and certified in a register.

21.11.6. The mine manager should ensure that:

- (a) the mine has a sufficient number of portable gas detectors capable of detecting the presence of methane, carbon monoxide and oxygen in the mine atmosphere; and
- (b) each portable gas detector used at the mine is certified as:
  - (i) suitable for use in an underground mine;
  - (ii) having explosion protection requirements;
  - (iii) capable of detecting the type of gas for which it is intended to be used; and
  - (iv) being accurate and reliable.

21.11.7. Supervisory officials should be provided with, and carry at all times while underground:

- (a) an approved methanometer and an approved device for indicating a deficiency of oxygen; or

- (b) a single approved device for determining and indicating a deficiency of oxygen.

#### 21.12. Atmospheric monitoring systems for mine-wide monitoring

21.12.1. National laws or regulations should establish standards on requirements for mine-wide monitoring with the use of AMS in underground coalmines to monitor continuously the mine environment. Given the potential for mine fires, explosions, outbursts of gases or materials, or mine roof failures that can damage or destroy ventilation controls and other hazards, continuous monitoring of the mine environment is essential to protect workers.

21.12.2. The types of AMS used should include monitoring of carbon monoxide, heat and/or smoke, methane, carbon dioxide, oxygen, and ventilation pressures, velocities or direction.

21.12.3. Sensors used to monitor for carbon monoxide, heat, smoke, methane, carbon dioxide, oxygen air velocities, pressures or directions should be of a type listed and installed in accordance with the recommendations of a nationally recognized testing laboratory and approved by, or conform to specifications set out by, the competent authority.

21.12.4. The monitoring system, when used, should:

- (a) continuously monitor the mine atmosphere at the places specified by national laws or regulations or the competent authority to detect methane, carbon monoxide, or heat or smoke, carbon dioxide, oxygen and ventilation changes;
- (b) automatically detect or calculate the values and trends of the following:
  - (i) gas concentrations;
  - (ii) the ratio of carbon monoxide to oxygen;

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- (iii) the ratio of carbon monoxide to carbon dioxide;
  - (iv) gas explosibility; and
  - (v) abnormal changes in ventilation pressures, velocities or direction;
- (c) automatically activate an alarm if a gas alarm level is exceeded;
- (d) record the values and trends mentioned in (b) above and display the record:
- (i) at the surface of the mine where the record can be easily accessed by coalmine workers; and
  - (ii) in a way that the record can be easily read by the workers; and
- (e) keep the information on which the values and trends mentioned in (d) above were based at the mine in a way that enables the information to be easily accessed and inspected.

21.12.5. Each monitoring system should have an alternative electricity supply to ensure it continues to function if the normal electricity supply fails, and should be designed as intrinsically safe to continue to operate should the mine ventilation fail.

21.12.6. The mine manager should designate a surface location at the mine where signals from the AMS will be received and two-way voice communication is maintained with each working district/section, and with other areas designated in the approved fire prevention and emergency response plan contained in Chapter 9.

21.12.7. The employer should:

- (a) designate an AMS operator, who has received special training, to monitor and promptly respond to all AMS signals;
- (b) maintain an up to date map or schematic at the designated surface location that shows the locations and type of AMS sensor

at each location, and the intended air flow direction at these locations; and

- (c) maintain a list, at the designated surface location, of the names of the designated AMS operators and other appropriate personnel, including the designated person responsible for initiating an emergency mine evacuation, and the method to contact these persons.

21.12.8. (1) The AMS should be designed automatically to provide easily detectible visual and audible signals at the designated surface location:

- (a) for any interruption of circuit continuity and any electrical malfunction of the system; and
- (b) when the carbon monoxide, heat, smoke, methane, carbon dioxide or oxygen concentration or ventilation pressures, velocities or direction at any sensor reaches the alert and alarm levels as specified by the competent authority.

(2) The system should automatically provide easily detectible visual and audible signals at all affected working districts/sections and at all affected areas when the carbon monoxide, heat, smoke, methane, carbon dioxide or oxygen concentration or ventilation pressures, velocities or direction at any sensor reaches the alarm level as specified by the competent authority. Methane signals should be distinguishable from other signals.

(3) The system should automatically provide visual and audible signals at other locations as specified in the fire protection and emergency response plan addressed in section 9.2 when the carbon monoxide, heat, smoke, methane, carbon dioxide or oxygen concentration or ventilation pressures, velocities or direction concentration at any sensor reaches the alarm level as specified by the competent authorities. Methane alarms must be distinguishable from other signals.

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(4) The AMS should be designed to identify at the designated surface location the operational status of all sensors.

(5) The system should also automatically provide visual and audible alarm signals at the designated surface location and at all affected working sections, when carbon monoxide or other gases reach alert levels, as specified by the competent authority, at any two consecutive sensors at the same time. These signals should be seen or heard by the AMS operator and miners working at these locations.

21.12.9. AMS sensors for carbon monoxide or smoke should be installed: in conveyor belt entries and particularly around belt drives, transfer points, the belt tailpiece and at frequent locations along conveyor belts; at unattended electrical equipment; in air courses ventilating haulage ways; entries where trolley wire is installed; in escape routes; in the immediate return for mining districts/sections; in the return airway from each unsealed waste, idle workings and goaf (a mined-out area) area; in the return of each airway at the upcast shaft; in other strategic locations in return air courses; in areas susceptible to spontaneous combustion; and in other locations specified by the competent authorities.

21.12.10. AMS sensors for methane should be installed at strategic locations in conveyor belt entries at unattended electrical equipment; in air courses ventilating haulage ways; at entries where trolley wire is installed; in escape routes; in the immediate return for mining districts/sections; in the return airway from each unsealed waste, idle workings and goaf area; in the return of each airway at the upcast shaft; and in other strategic locations in return air courses and other locations specified by the competent authorities. Methane sensors should be installed in mining districts/sections in a manner that detects gas concentrations before it migrates to the ener-

gized equipment that is not flameproof, and that automatically de-energizes the power centres supplying power to the equipment.

21.12.11. AMS sensors for carbon dioxide or oxygen should be used in areas of the mine which have evidence of, or have a history of, unstable levels and locations specified by the competent authorities. Oxygen sensors should be used in areas that are susceptible to spontaneous combustion.

21.12.12. AMS sensors to measure for ventilation pressures, velocity and direction should be utilized in return and intake air courses at strategic locations that would provide constant data on the proper ventilation of the mine, including main intakes and returns and mining districts and sections.

21.12.13. AMS sensors to measure heat could be utilized to monitor enclosed electrical installations and other facilities listed in paragraph 9.4.4.

21.12.14. (1) All AMS sensors should be located in the mine so that measurements are representative of the mine atmosphere that is intended to be measured.

(2) Carbon monoxide or smoke sensors should be installed near the centre in the upper third of the entry, in a location that does not expose personnel working on the system to unsafe conditions, and should not be located in abnormally high areas or in other locations where air-flow patterns do not permit products of combustion to be carried to the sensors.

(3) Methane sensors should be installed near the centre of the entry, at least 30 centimetres (approximately 12 inches) from the roof, ribs and floor (depending on the purpose of the monitoring), in a location that would not expose personnel working on the system to unsafe conditions.

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(4) Carbon dioxide, oxygen and ventilation pressures, velocities or direction sensors should be placed at the optimum locations to obtain the sampling results desired.

(5) Sensors should be located in such a way that the air current passes by them in the proper direction to monitor effectively the areas or conditions intended.

(6) All sensors, wiring, power sources and components should be installed in a manner to provide maximum protection from damage or disruption.

21.12.15. Unless national laws, regulations or the competent authority specify otherwise, the alert and alarm levels should be as follows:

- (1) Alert levels for carbon monoxide should be set no higher than 5 parts per million (ppm) above the ambient level of that area of the mine, and the alarm at 10 ppm.
- (2) The alarm for smoke sensors should not exceed an optical density of 0.02 per metre (approximately 3 feet).
- (3) Alert and alarm levels for methane should be established for the particular area by those contained in paragraph 21.9.2.
- (4) The alarm level for oxygen should be determined as defined in paragraph 21.1.3 for sufficient air to breathe. Where the atmosphere is being monitored for spontaneous combustion or where combustion may occur with the presence of oxygen, alerts and alarms would have to be determined based on the conditions and trends.
- (5) The alert and alarm levels for ventilation changes in pressure, velocity or direction should be determined by the specific conditions being monitored.

21.12.16. (1) At least once each shift, sensors should be visually examined.

(2) At least once every seven days, alarms for AMS should be functionally tested for proper operation.

(3) At least once each month, all AMS sensors should be tested and calibrated according to the manufacturer's specifications.

21.12.17. (1) A record should be maintained in a secure book, or electronically in a computer system that is secure:

- (a) of all tests of the AMS system listed in paragraph 21.12.16 and corrective actions taken;
- (b) of any alert or alarm signal, including the date, time, location and type of sensor, and the cause for the activation; and
- (c) of an AMS malfunction, including the date, extent and cause of the malfunction, and the corrective action taken to return the system to proper operation.

(2) The person entering the record must include their name, signature and the date in the record.

21.12.18. All AMS operators, and those inspecting the AMS systems, should be thoroughly trained.

### 21.13. Methane drainage

21.13.1. (1) Where methane drainage systems are used, either underground or on the surface, a detailed sketch of each system, including a description of safety precautions used with the systems, should be included in the mine ventilation plan specified in section 21.2.

(2) If the methods for extracting methane, either from underground or the surface in areas where mining is occurring or has occurred, impacts the mine ventilation, the mine ventilation plan should detail the methods for extracting the methane and describe the specific safeguards and controls in place to prevent adverse effects on the mine ventilation.

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21.13.2. Before the drilling of any borehole required for the purpose of tapping methane and draining it through any methane drainage system, arrangements should be made to ensure that there is available a pipe range in which any methane which may be tapped can be collected and conveyed to a point where it may be discharged safely.

21.13.3. No borehole should be drilled unless it is drilled through a device with which the borehole may be sealed to prevent a sudden flow of methane escaping through the borehole.

21.13.4. Before any person starts to bore any hole in stone, they should ensure that water is flowing through the drill rods, and during the drilling process ensure that water continues to flow through the drill rods and out of the mouth of the borehole.

21.13.5. Arrangements should be made at each borehole to permit the measurement of the rate of gas flow, together with the percentage of methane in that gas flow.

21.13.6. Each standpipe forming part of the methane drainage system should be inserted and sealed in the borehole in such a way as to minimize leakage of methane or air around the pipe.

21.13.7. No standpipe should be joined to a pipe range by other than a flexible connection.

21.13.8. Every methane range installed in a mine should be:

- (a) so designed and constructed as to permit, at suitable places along its length, samples to be taken of methane flowing through it, and water to be drained from it;
- (b) adequately supported; and
- (c) so painted that there is a yellow band (the international colour code for methane) near to every joint in the range and that the valves used in the range are also painted yellow.

21.13.9. When a pipe is to be connected to a methane drainage range, it should be done in such a way as to minimize the amount of air entering the range.

21.13.10. No exhauster should be installed in a methane drainage system, unless:

- (a) it is of a type approved by the competent authority;
- (b) it is so constructed and installed that when the exhauster is not working, methane will not be able to flow through it in a reverse direction;
- (c) it and the system are so arranged that, when the exhauster is not working, methane will not be able to flow through it in a reverse direction;
- (d) it is connected to earth in such a manner as will ensure immediate electrical discharge without danger.

21.13.11. Only suitably constructed buildings should be used to house surface exhausters, and they should not be used for any other purpose.

21.13.12. All electrical apparatus used in conjunction with the exhauster should be certified either as intrinsically safe or flameproof.

21.13.13. (1) Except where the calorimeter employed for monitoring methane uses a naked flame, no other lamp or light should be used in the exhauster house unless it is a permitted light.

(2) In addition, each naked-light calorimeter should be installed in an enclosure which is ventilated separately from the calorimeter room.

21.13.14. The aforementioned enclosure should not be opened, except by an authorized person who has determined that it is safe to do so.

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21.13.15. (1) As far as practicable, every place where methane is discharged should be kept free from any ignition sources.

(2) This should not apply to places where the methane is utilized.

21.13.16. Where methane is discharged into the atmosphere on the surface, such discharge points should be fitted with suitable flame traps to prevent flames entering the system.

21.13.17. National laws or regulations should fix the minimum percentage of methane by volume which should be fed into a utilization plant.

21.13.18. Where methane is discharged from a system below ground, this point should be closed off by a fence of sufficient size to ensure that the percentage of methane in the air at the outside of the fence does not exceed the figure fixed by national laws or regulations, which should not exceed 2 per cent.

21.13.19. Methane should not be discharged from any system into an intake airway.

21.13.20. Abandoned workings in which methane may accumulate should be dealt with in an appropriate manner to contain or eliminate any hazardous accumulation.

21.13.21. It should be the duty of the manager of every mine where a methane drainage system is installed to arrange for the training of a sufficient number of competent persons to be in charge of the system.

## **22. Lamps and lighting**

Where national laws, regulations and standards do not contain prescription or contain ineffective or outdated prescription as to lamps and lighting, this chapter provides guidance. The provisions outlined in this chapter should be used in conjunction with the proper application of a hazard identification, risk assessment and control process.

### **22.1. Miners' electric cap lights**

22.1.1. (1) Only electric cap lights approved by, or in conformity with specifications set out by, the competent authority and provided by the employer should be used.

(2) They should be durable in construction, practical in operation and suitable for the conditions of underground service.

(3) They should meet specific testing requirements established by the competent authority and offer no probable explosion hazard if used in gassy or dusty mine atmospheres, or bodily hazard from the spilling of the battery electrolyte.

### **22.2. Flame safety lamps**

22.2.1. Only safety lamps approved by, or in conformity with specifications set out by, the competent authority and provided by the employer should be used.

22.2.2. All lamps should be numbered and maintained constantly in good condition by authorized, competent persons who are trained in the care and maintenance of the lamps.

22.2.3. Every person who receives a lamp should:

- (a) check to make sure it is complete and in good order;
- (b) refuse any lamp that does not fulfil these conditions;

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- (c) handle the lamp carefully;
- (d) report any damage to the lamp to the person in charge of the lamp room, who should keep a record of all damaged lamps;
- (e) report to the lamp room, if that person returned a lamp which is different to the one checked out;
- (f) not attempt to open a safety lamp while underground;
- (g) not attempt to relight a flame safety lamp provided with an internal relighter if there is any uncertainty as to the presence of methane or the safe condition of the lamp; and
- (h) not place a flame safety lamp in a ventilation duct.

22.2.4. The relighting of flame safety lamps should be done only in conformity with the provisions established in national laws or regulations or by the competent authority.

22.2.5. All lamps should be serviced in a special “lamp room”.

22.2.6. Lamps should be cleaned, fitted and refilled in a room separated from the place where the fuel is stored.

22.2.7. (1) Stoves, open lights and smoking should be prohibited in a lamp room where flame safety lamps are being handled.

(2) This prohibition should be posted at the entrance to the lamp room.

22.2.8. No unauthorized person should enter the lamp room.

22.2.9. The lamp room should be equipped with an adequate number of fire extinguishers.

22.2.10. It should be the duty of the authorized competent persons in charge of the lamp room to keep a record of the name of every person to receive a lamp and the number of the lamp they received that goes underground.

### 22.3. Lighting and illumination underground

22.3.1. (1) National laws or regulations should specify the places below ground where illumination should be provided.

(2) These specified places should include:

- (a) the entrance to each shaft or outlet, together with the loading points associated therewith;
- (b) every siding, pass-by and junction, every place where vehicles are regularly coupled or uncoupled or regularly attached or detached from a haulage system, and every place where vehicles are filled mechanically;
- (c) all locations where workers normally board transportation equipment at the beginning and end of shifts;
- (d) every room or place which houses any machine or motor, and underground maintenance facilities;
- (e) self-propelled equipment, continuous mining machines and coal-loading equipment, roof-bolting machines, and short-wall and longwall mining equipment; and
- (f) any other place specified by the competent authority.

22.3.2. The requirements specified in paragraph 22.3.1 are in addition to those stated in paragraph 19.3.6.

22.3.3. Self-propelled equipment is equipment which possesses the capability of moving itself or its associated components from one location to another by electric, hydraulic, pneumatic or mechanical power supplied by a source located on the machine or transmitted to the machine by cables, ropes or chains.

22.3.4. In working places in which continuous miners and coal-loading equipment are operated, the areas which should be illuminated include the face, sides (ribs), roof, floor and exposed surface of mining equipment, which are between the face and the inbye end of the shuttle car or other conveying equipment while in position to receive material.

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22.3.5. When self-propelled mining equipment is operated in a working place, the areas within a miner's normal field of vision that should be illuminated in the working place should be prescribed by the competent authority.

22.3.6. In working places where shortwall or longwall mining equipment is operated, the areas which should be illuminated include the area for the length of the self-advancing roof support system between the gob-side of the travel way and the side of the block of coal from which coal is being extracted; the control station; the headpiece and tailpiece of the face conveyor; and the roof and floor.

22.3.7. The luminous intensity (surface brightness) of surfaces that are in a miner's normal field of vision of areas in working places that are required to be lighted should be not less than  $0.20 \text{ cd/m}^2$  ( $0.06 \text{ lumen/sq. ft.}$ ) as measured at distances prescribed by national laws or regulations or the competent authority.

22.3.8. National laws or regulations should specify the requirements for lighting on coalfaces. All lighting used in areas of the mine that require electrical equipment to meet the flameproof standard would also have to meet that standard.

22.3.9. (1) National laws or regulations should specify the places below ground which should be well illuminated.

(2) These places should include:

- (a) the entrances to each shaft or outlet, and the associated sidings which are regularly used;
- (b) every siding, pass-by and junction, every place where vehicles are regularly coupled or uncoupled or regularly attached or detached from a haulage system, and every place where vehicles are regularly filled mechanically; and
- (c) every room or place which houses any machine, motor, electrical transformer or switchgear.

## **23. Competence, education and training**

Where national laws, regulations and standards do not contain prescription or contain ineffective or outdated prescription as to competence, education and training, this chapter provides guidance. The provisions outlined in this chapter should be used in conjunction with the proper application of a hazard identification, risk assessment and control process.

Education and training are essential for all persons working in underground coalmines, particularly since historically underground coalmining has been one of the highest risk activities as far as the safety and health of the workforce are concerned. Education and training play a central role in fostering a preventive safety and health culture in coalmines and in eliminating practices and conduct that endanger safety and health in coalmines.

A number of roles at coalmines require specific expertise, qualifications and certifications. These include managers, mining engineers, examiners, miners, supervisory officials, contractors, mine electricians, mine surveyors, shot-firers and hoisting operators, who need special education and training.

A number of roles specific to the underground coalmining industry require special training. These include mechanics, continuous miners and longwall and plant operators.

### **23.1. General provisions**

23.1.1. No person should be employed to work at any coalmine unless that person has received the necessary instruction and training so as to be able to do the work competently and safely.

23.1.2. National laws or regulations should establish standards for the training of all workers at coalmines, including miners, supervisory officials and contractors, which should include the provisions

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of this chapter. The employer should prepare, and national laws or regulations should also require, a training plan which should specify:

- (a) the period and type of induction training for new workers to the industry;
- (b) the period and type of training required for persons assigned new work;
- (c) the period of training and employment of persons on surface work before they proceed to work underground;
- (d) the period of attendance by persons at approved courses of training at a mining school or other approved place and, where practicable, the inclusion in the curriculum of training in occupational health and safety hazards, emergency response and first-aid techniques vital to saving lives;
- (e) the period of training for new workers under close personal supervision when starting work underground;
- (f) coalface training that covers all operations and specifies the period of training in each operation, including training required when new systems of work are introduced;
- (g) the requirement that each person employed at a mine should undergo refresher training at intervals to be specified and in a manner and language understood by the workers;
- (h) the training and retraining of supervisory officials, examiners, electricians, hoisting operators and other such personnel;
- (i) the training of contract workers who work at the mine;
- (j) the requirement that records of the training of each person be kept by a training officer appointed by the manager; and
- (k) the duty of the training officer to supervise the training of persons who work at the mine and to report, in writing, on training matters as required by the manager.

23.1.3. Training programmes should:

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- (a) be conducted by competent persons;
- (b) include participant evaluation for comprehension and retention of the training;
- (c) be reviewed periodically by the safety and health committee, where it exists, or by the employer in consultation with workers or their representatives, and modified as necessary; and
- (d) be documented.

23.1.4. The form and the content of training, which should be required by national laws or regulations, particularly for new workers, should be devised and implemented by employers in consultation with workers or their representatives, should be in accordance with the identified needs and should include:

- (a) pertinent aspects of relevant legislation, codes of practice, instructions on the prevention of accidents and disease, and collective agreement, as well as the rights, responsibilities and duties of competent authorities, employers, contractors and workers;
- (b) assessments, reviews, exposure measurements, and the rights and duties of workers in this regard;
- (c) the role of health surveillance, the rights and duties of workers in this regard, and access to information;
- (d) the hazards associated with methane and other mine gases and the importance of mine ventilation and gas detection;
- (e) the hazards associated with coalmine dust and the measures needed to prevent coalmine explosions;
- (f) the hazards associated with mine fires and measures needed to prevent them and extinguish them should they occur;
- (g) the hazards of unsafe mine roof and sides, and the measures needed to prevent unintended falls, outbursts and cave-ins;

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- (h) hazard warning signs and symbols for hazardous ambient factors which may occur;
- (i) any other relevant hazards;
- (j) the health risks of respirable coalmine dusts and measures needed to prevent disease;
- (k) the dangers of crushing accidents and electrocution while working in confined spaces with large mobile equipment and energized electrical equipment;
- (l) procedures to be followed in an emergency, emergency measures, firefighting and fire prevention, and first aid;
- (m) instructions on PPE as may be necessary, its significance, correct use and limitations, and in particular on factors which may show inadequacy or malfunction of the equipment, and the measures which may be required for the workers to protect themselves;
- (n) the nature and degree of hazards or risks to safety and health which may occur, including any factors which may influence those risks, such as appropriate hygiene practices;
- (o) the correct and effective use of prevention, control and protection measures, especially engineering controls, and workers' own responsibility for using such measures properly;
- (p) ergonomically correct methods for the handling of materials and tools;
- (q) methods of identifying harmful chemicals and agents, including use of material safety data sheets (MSDS) which should be provided in languages and at educational levels that ensure they will be understood by workers;
- (r) appropriate hygiene practices to prevent, for example, the transmission of hazardous substances off site;

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- (s) cleaning, maintenance, storage and waste disposal, to the extent that these may cause exposure for the workers concerned;
- (t) suitable instruction in the hazards connected with the work and in the working environment, as well as training in precautions necessary to avoid accidents, injuries and occupational diseases; and
- (u) training of safety and health committees.

23.1.5. Training should be provided to all participants at no cost and should take place during working hours. If this is not possible, the timing and other arrangements should be agreed upon between the employer and the workers' representatives.

23.1.6. Employers should ensure that training and information requirements and procedures are kept under review, as part of the assessment review and documentation.

### 23.2. Qualifications of managers and supervisory officials

23.2.1. Each mine operation should employ managers, supervisory officials, examiners, mining engineers and others responsible for the health and safety of the mining operations who have been certified as competent in accordance with national laws or regulations. Such certifications and qualifications should be established from generally accepted mine health and safety practices.

23.2.2. (1) Candidates for certifications of competency for positions, such as mine manager, mine foreman, assistant mine foreman or deputy, and/or mine examiner or their equivalent, should have completed a specified number of years of practical work experience in underground coalmines which should include at least one year of experience on or at a working district/section.

(2) Candidates for these positions should have to pass a test administered by the competent authority covering the various aspects

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of the mining laws, practices and conditions they would be dealing with in their official positions.

23.2.3. Successful management requires the integration of OSH into all the facility's activities, including contractors' activities.

23.2.4. Responsibility for managing OSH within any organization should be placed upon managers and supervisory officials at each level in the job hierarchy. Managers and supervisory officials should be in possession of an appropriate qualification and training, or have gained sufficient knowledge, skills and experience to qualify on the basis of competence, to ensure that they are able to:

- (a) plan and organize safe operations, including the identification of hazards, the assessment of risks and the implementation of preventive measures;
- (b) establish, implement and maintain an OSH management system;
- (c) monitor the status of OSH in those operations for which they are responsible; and
- (d) take corrective action in the event of non-compliance with requirements.

23.2.5. Managers should receive technical and other training to allow them to fulfil their responsibilities for OSH.

### **23.3. Qualifications, training and skills testing of workers**

23.3.1. The employer should:

- (a) provide workers with the instruction and training that is necessary to enable them to perform their work safely and without injury;
- (b) ensure that every worker has the training to become familiar with work-related hazards and risks to which they may be ex-

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posed and the measures that must be taken to control those risks;

- (c) ensure that every worker is made aware of the relevant laws, regulations, standards, instructions and advice relating to prevention of accidents and diseases as they relate to underground coalmining; and
- (d) evaluate the education and training of workers to ensure their effectiveness.

23.3.2. The employer should ensure that every worker is properly trained:

- (a) to deal appropriately with every significant risk to safety and health that is associated with any work that the worker has to perform;
- (b) in the measures necessary to control those risks to safety and health;
- (c) in the procedures to be followed to perform that worker's work; and
- (d) in relevant emergency procedures.

### 23.4. Qualifications of contractors and others working in underground coalmines

23.4.1. The management of OSH with contractors and other parties should be consistent.

23.4.2. Best practices in OSH at the facility should be applied to contractors.

23.4.3. Only those contractors who can demonstrate good performance and an adequate safety and health management system should be used.

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23.4.4. The OSH management systems of contractors and their OSH record should carry similar weight to other performance factors when considering the choice of contractors.

23.4.5. Before commencing work, on-site pre-work briefings should be completed that cover the scope of work, the work method, the identification of key hazards and risk assessment. All relevant safety permits should be completed before the job is begun and the mining worksites should be supervised and examined to the same standards that exist for the mining operation.

## **24. Personal protective equipment**

Where national laws, regulations and standards do not contain prescription or contain ineffective or outdated prescription as to personal protective equipment (PPE), this chapter provides guidance. The provisions outlined in this chapter should be used in conjunction with the proper application of a hazard identification, risk assessment and control process.

### **24.1. General provisions**

24.1.1. As a supplementary protection against exposure to hazardous conditions in the mining of coal where the safety of workers cannot be ensured by other means, such as eliminating the hazard, controlling the risk at source or minimizing the risk, suitable and sufficient PPE, having regard to the type of work and risks, and in consultation with workers and their representatives, should be used by the workers and provided and maintained by the employer, without cost to the workers.

24.1.2. Items of PPE provided should comply with the relevant national standards and criteria approved or recognized by the competent authority.

24.1.3. Those responsible for the management and operation of the personal protection programme should be trained in the selection of the proper equipment, in assuring that it is correctly fitted to the people who use it, in the nature of the hazards the equipment is intended to protect against, and provide adequate comfort, and in the consequences of poor performance or equipment failure.

24.1.4. PPE should be selected considering the characteristics of the wearer and the additional physiological load or other harmful effects caused by the PPE. It should be used, maintained, stored and replaced in accordance with the standards or guidance for each

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hazard identified at the facility and according to the information given by the manufacturer.

24.1.5. PPE should be examined periodically by the user to ensure that it is in good condition and replaced or repaired, as necessary, by the employer at no cost to the user.

24.1.6. Different PPE and their components should be compatible with each other when they are worn together.

24.1.7. PPE should be ergonomically designed and, as far as practicable, should not restrict the user's mobility or field of vision, hearing or other sensory functions.

24.1.8. Employers should ensure that the workers who are required to wear PPE are fully informed of the requirements and of the reasons for it, and are given adequate training in the selection, wearing, maintenance and storage of this equipment.

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

24.1.10. The PPE should not be used for longer than the time indicated by the manufacturer.

24.1.11. Workers should make proper use of the PPE provided, and maintain it in good condition, consistent with their training, and be provided with the proper means of doing so.

24.1.12. 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.

24.1.13. Protective equipment that may be contaminated by materials hazardous to health should not be laundered, 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.

24.1.14. PPE should not contain hazardous substances.

### 24.2. Head protection

24.2.1. Helmets should be worn by all persons at coalmines.

24.2.2. Any helmet that has been submitted to a heavy blow, even if there are no evident signs of damage, should be discarded.

24.2.3. If splits or cracks appear, or if a helmet shows signs of ageing or deterioration of the harness, the helmet should be discarded.

24.2.4. Where there is a hazard of contact with exposed conductive parts, only helmets made of non-conducting material should be used.

24.2.5. Helmets for persons working overhead should be provided with chin straps.

24.2.6. In addition to safety, consideration should also be given to the physiological aspects of comfort for the wearer. The helmet should be as light as possible, the harness should be flexible and should not irritate or injure the wearer and a sweatband should be incorporated.

24.2.7. All protective headgear should be cleaned and checked regularly.

24.2.8. Special helmets designed to cover the full head should be provided to workers in areas susceptible to rock and coal outbursts.

### 24.3. Face and eye protection

24.3.1. Face shields or eye protectors should be used to protect against flying particles, fumes, dust and chemical hazards.

## **Safety and health in underground coalmines**

24.3.2. Goggles, helmets or shields that give maximum eye protection for each welding and cutting process should be worn by operators, welders and their helpers.

24.3.3. Welding and cutting processes emit radiation in the ultraviolet, visible and infrared bands of the spectrum, which are all able to produce harmful effects upon the eyes. In welding operations, helmet-type protection and hand-shield type protection should be used. Protection is also necessary for the welder's assistant and others who may be exposed to the hazards.

24.3.4. With the use of face and eye protectors, due attention should be paid to comfort and efficiency.

24.3.5. The protectors should be fitted and adjusted by a person who has received training in this task.

24.3.6. Comfort is particularly important in helmet- and hood-type protectors as they may become almost intolerably hot during use. Air lines can be fitted to prevent this.

24.3.7. Face and eye protectors should give adequate protection at all times, even with the use of corrective vision devices.

24.3.8. Eye protectors, including corrective lenses, should be made of appropriate high-impact material.

24.3.9. Full face protection should be provided to workers in areas susceptible to rock and coal outbursts.

## **24.4. Upper and lower limb protection**

24.4.1. Hands and feet should be protected against physical, chemical and other hazards.

24.4.2. The height to which safety footwear covers the ankle, knee or thigh depends on the hazard, although comfort and mobility should be considered.

## **Personal protective equipment**

24.4.3. Shoes or boots should be without tongues and trouser legs should be pulled over the top of the boot, strapped tight and not tucked inside.

24.4.4. Slip-resistant properties should be taken into account when choosing footwear.

24.4.5. Knee protectors may be necessary, especially where work involves kneeling.

24.4.6. All professional footwear should be kept clean and dry when not in use and should be replaced as soon as necessary.

24.4.7. Full body protection should be provided to workers in areas susceptible to rock and coal outbursts.

### **24.5. Respiratory protective equipment**

#### **24.5.1. Respirators**

24.5.1.1. When effective engineering controls are not feasible, or while they are being implemented or evaluated, respirators, appropriate to the hazard and risk in question, should be used to protect the health of the worker.

24.5.1.2. 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.

24.5.1.3. When selecting respirators, an appropriate number of sizes and models should be available from which a satisfactory respirator can be selected. Different sizes and models should be available to accommodate a broad range of facial types. Workers should be fit-tested for respirators.

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24.5.1.4. Respirators should be cleaned and sanitized periodically. Respirators intended for emergency use should be cleaned and sanitized after each use.

24.5.1.5. The user should be sufficiently trained and familiar with the respirator in order to be able to inspect the respirator immediately prior to each use to ensure that it is in proper working condition. Inspection may include the following:

- (a) tightness of connections;
- (b) the condition of the respiratory inlet and outlet covering;
- (c) head harness;
- (d) valves;
- (e) connecting tubes;
- (f) harness assemblies;
- (g) hoses;
- (h) filters;
- (i) cartridges;
- (j) end-of-service life indicator;
- (k) electrical components;
- (l) shelf-life date; and
- (m) the proper function of regulators, alarms and other warning systems.

24.5.1.6. Respirators should be properly stored. Damage may occur if they are not protected from physical and chemical agents such as vibration, sunlight, heat, extreme cold, excessive moisture or damaging chemicals.

24.5.1.7. Each respirator should be used with an understanding of its limitations, based on a number of factors such as the level and duration of exposure, the characteristics of the chemical and the service life of a respirator.

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24.5.1.8. Workers should be medically evaluated for their ability to wear a respirator safely before they are required to do so.

### 24.5.2. Self-contained self-rescue devices

24.5.2.1. (1) Each employer should make available to each person who goes underground a self-rescue device or devices, approved by the competent authority, which is adequate to protect such person for one hour or longer. Additional self-rescue devices should be properly stored in various locations underground to allow persons added protection for escape from the farthest distance underground to the surface or, in the event of escape being blocked or not possible, to a safe refuge chamber underground from which persons will be rescued by suitable means of access.

(2) Before any person goes underground they should be instructed and trained in the use and location of the self-rescue device or devices made available at the mine.

24.5.2.2. (1) Each person who goes underground should be provided with a self-contained self-rescuer (SCSR) which is a closed-circuit type, self-contained breathing apparatus for escape only from underground coalmines. These devices should be approved by the competent authority meeting recognized standards and specifications and should be immediately available to the person while underground.

(2) If a less protective filter type self-rescuer, gas-mask type device is approved by the competent authority for escape only from underground mines in lieu of or in conjunction with the SCSR, it should meet recognized standards and specifications, and provide at least one hour of protection against carbon monoxide.

24.5.2.3. Before and after each time a self-rescue device is worn or carried by a person, the device should be inspected for damage and for the integrity of its seal by a person trained to perform

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this function. Self-rescue devices with broken seals or which are damaged so that the device will not function properly should be removed from service.

24.5.2.4. In addition to the general inspections, self-rescue devices should undergo more thorough and frequent testing procedures which should be established by the competent authorities.

### **24.6. Hearing protection**

24.6.1. When effective engineering controls are not feasible, or while they are being implemented or evaluated, hearing protection should be used to protect the health of workers.

24.6.2. Hearing loss of speech frequencies may occur with elevated long-term exposure to noise. The use of hearing protectors gives the best results to users who are well informed of the risks and trained in their use. If earplugs are used, special attention should be paid to the proper fitting technique.

24.6.3. Hearing protectors should be comfortable, and the users should be trained to use them properly. Special attention should be paid to possible increased risk of accidents due to the use of hearing protectors. Earmuffs reduce the capacity to locate sound sources and prevent warning signals from being heard. This is especially true for workers with considerable hearing loss.

24.6.4. No model is suitable for all persons. Those wearing hearing protectors should be able to choose from alternative products that meet the attenuation criteria. Earplugs should not be the only solution as not all people can wear them.

24.6.5. Hearing protectors should be made available at the entrance to the noisy area and they should be put on before entering the noisy area. Noisy areas should be indicated by appropriate signs.

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24.6.6. Hearing protectors work well only if they are well maintained. Good maintenance consists of cleaning, changing replaceable parts such as cushions, and overall monitoring of the state of the hearing protector.

24.6.7. Hearing protectors should be evaluated through an audiometric test programme for exposed workers.

### **24.7. Protection from falls**

24.7.1. When other measures do not eliminate the risk of falling, workers should be provided with and trained in the use of appropriate fall protection equipment, such as harnesses and lifelines. Workplaces and roadways in which there are fall hazards or which border on a danger zone should be equipped with devices which prevent workers from falling into or entering the danger zone.

24.7.2. Devices should be provided to prevent workers from falling through floors and openings.

24.7.3. Safety harnesses should be worn where required and the lifeline should be attached to an adequate anchor point.

24.7.4. Harnesses should be chosen that are safely used with other PPE that may be worn simultaneously.

24.7.5. Appropriate and timely rescue should be provided when using fall-arrest equipment to prevent suspension trauma.

### **24.8. Work clothing**

24.8.1. Where required on the basis of a risk assessment, workers should wear the appropriate protective clothing provided by the employer.

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

- (a) the adequacy of the design and the fit of the clothing, allowing freedom of movement for the worker to perform tasks, and whether it is suitable for the intended use;
- (b) 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, as far as technologically possible; and
- (c) the special requirements of workers, such as the need for reflective clothing or special protective padding during exposure to rock or coal outbursts.

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

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

24.8.5. The employer should ensure that a worker removes protective clothing before leaving the containment area or any workplace exposed to a substance that may pose a risk outside the containment area. Contaminated clothing should be disposed of safely.

24.8.6. Inspection of protective clothing should be performed by the user before each use.

## **25. Contingency, emergency preparedness and rescue**

Where national laws, regulations and standards do not contain prescription or contain ineffective or outdated prescription as to contingency, emergency preparedness and rescue, this chapter provides guidance. The provisions outlined in this chapter should be used in conjunction with the proper application of a hazard identification, risk assessment and control process.

### **25.1. General**

25.1.1. National laws or regulations should require, and every employer should have, a comprehensive programme in place to respond to any injury, illness or mine emergency that may occur at each mine, including foreseeable industrial and natural disasters. This programme should include: immediate first-aid treatment, medical treatment, transportation and evacuation of injured persons; procedures to respond to emergencies that arise at the mine; and arrangements for the rescue of persons incapacitated or trapped in coalmines. This plan should be a part of the fire prevention and emergency response plan contained in Chapter 9.

25.1.2. The first aid, medical and emergency response plans should include, at a minimum, the following:

- (a) sufficient supplies of all first-aid equipment and supplies necessary to respond to injuries and illness that may occur at the mine, and which are immediately accessible and strategically located throughout the mining operation;
- (b) arrangements for immediate response and care to injuries and illnesses that require emergency medical attention;

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- (c) sufficient numbers of personnel at the mine who are trained to provide first aid and to respond to medical emergencies, including those that are life threatening;
- (d) procedures, equipment and materials in place to safely retrieve, carry and transport injured persons quickly to proper medical facilities;
- (e) emergency response procedures that include quick and safe evacuation of mines and workplaces, rescue of persons by trained mine-rescue personnel; and
- (f) preparations to respond to injuries, illnesses, accidents and mine emergencies by thorough training of all personnel and workers in the respective roles and responsibilities of response, location of all first-aid medical facilities and evacuation procedures.

25.1.3. Emergency planning, prevention, preparedness and response arrangements should be designed to protect both workers and the public and should be established in cooperation with external emergency services.

25.1.4. Notwithstanding the requirements regarding telephonic installations elsewhere in this code, telephones or an equivalent communication system should be installed at a sufficient number of suitable points underground in each mine to allow communication between the different parts of the mine and also between the underground workings and the surface. As far as practicable, the employer should ensure the integrity of the relevant communication systems in the event of fire, roof falls, explosions, inundations or other potential damage. Furthermore, the introduction of new communication technology – e.g. new forms of tracking devices, wireless communications technology, etc. – should be considered.

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25.1.5. If there is a central communication exchange below ground, it should be situated at the intake shaft, in a room or recess appropriately protected against damage and screened from noise and interference.

### **25.2. First aid and medical care**

#### **25.2.1. General**

25.2.1.1. Implementing an effective first-aid programme should be a cooperative effort, involving employers, workers and their representatives, occupational health and public health organizations, and the competent authority.

25.2.1.2. First aid, including the provision of trained personnel, should be available at every facility. First-aid boxes should always be clearly marked, be easily accessible and located near areas where accidents could occur. They should be able to be reached within one or two minutes. They should be made of suitable materials, and should protect the contents from heat, humidity, dust and abuse.

25.2.1.3. Although initial first aid should be given before moving the patient, simple means should also be accessible for immobilizing an injured or sick person if necessary and for transporting him or her from the scene of the accident.

25.2.1.4. The first-aid programme in each workplace should be designed in coordination with the medical facility, which provides the continuing care for its injured workers and where medical care should be established in cooperation with external emergency services.

25.2.1.5. Written instructions about first aid should be displayed by the employer at a strategic place at the facility and the

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employer should organize briefings for all workers. The following are essential parts of the briefing:

- (a) the organization of first aid at the facility and the procedure for access to additional care;
- (b) the identification of personnel who have been appointed as first-aid personnel;
- (c) the ways in which information about an accident should be communicated, and to whom;
- (d) the location of the first-aid box and the first-aid room;
- (e) what workers must do in the event of an accident and actions following an accident;
- (f) the location of the escape routes; and
- (g) the ways of supporting first-aid personnel in their task.

### **25.2.2. Surface first-aid arrangements**

25.2.2.1. At every mine where the total number of persons employed on one shift exceeds a figure specified by national laws or regulations, there should be provided and maintained in good order a suitable first-aid centre which should be:

- (a) a separate place not used for other purposes on the surface, conveniently near the main mine entrance, with easy approach, and access to persons carrying a stretcher;
- (b) adequately heated, lit and kept clean, and consist of treatment, rest, storage and waiting rooms; and
- (c) used only for first aid, medical examinations or ambulance work.

25.2.2.2. The first-aid centre treatment room should:

- (a) have an easy-clean, non-slip floor, easily washed walls, built-in storage cupboards, easy-clean working tops, and sinks with running water; and

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- (b) be equipped with a desk, chair, glass-topped treatment trolley with drawers, adjustable treatment chair, adjustable magnifying lamp, adjustable couch, and screen.

25.2.2.3. The first-aid centre restroom should have:

- (a) a door leading from the treatment room and wide doors leading outside to facilitate the movement of stretchers; and
- (b) a sink with running water, an adjustable couch and a rest chair.

25.2.2.4. The first-aid centre storeroom should be accessible from the treatment room and provided with lockable units and a locked door, and the waiting room or area should be accessible from the treatment room and provided with benches and chairs.

25.2.2.5. National laws or regulations should specify the minimum equipment to be kept in the first-aid centre.

25.2.2.6. The first-aid centre should be in the overall charge of first-aid officers who should have access to the services of a physician; no person other than a qualified nurse or a person who has undergone an approved course of first-aid training should be appointed by the manager to be in charge of the first-aid centre.

25.2.2.7. The first-aid officer(s) in charge of the first-aid centre should always be immediately available if they are not in continuous attendance while persons are at work in or about the mine.

25.2.2.8. (1) At small mines, where the total number of persons employed on any shift does not exceed the figure specified by national laws or regulations in accordance with paragraph 25.2.2.1, a first-aid room should be provided and kept constantly available for use.

(2) The room should have adequate means of heating and lighting, hot and cold water and interior surfaces which are easily

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cleaned, and national laws or regulations should specify the minimum equipment to be kept in the first-aid room.

25.2.2.9. These arrangements should be in the charge of a person or persons qualified in first-aid and life-saving techniques and one such person should always be readily available during working hours.

25.2.2.10. Where the resources of any mine are insufficient to fulfil the requirements of this chapter, two or more mines may pool their resources to meet these requirements, providing such facilities are readily accessible from each mine and the competent authority agrees with the arrangements.

### **25.2.3. Underground first-aid arrangements**

25.2.3.1. The employer should provide adequate first-aid arrangements, facilities and personnel appropriate for dealing with potential injury or harm resulting from hazards encountered underground. As far as practicable, appropriate means and trained personnel to provide first aid should be readily available at all times when persons are at work underground.

25.2.3.2. (1) A sufficient number of persons employed underground should hold up to date, approved first-aid certificates or possess equivalent qualifications.

(2) Where practicable, each of these qualified persons should regularly work with the same group of persons working below ground.

25.2.3.3. First-aid personnel should each carry a first-aid pouch which should contain at least the following items in usable condition:

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- (a) two triangular bandages;
- (b) small, medium and large sterile-packed dressings with integral bandage;
- (c) assorted adhesive plasters; and
- (d) an adequate number of medical gloves.

25.2.3.4. The employer should establish sufficient and suitable additional first-aid facilities to ensure adequate treatment beyond that provided for under paragraph 25.2.3.1 prior to timely transportation as may be required.

25.2.3.5. It should be the duty of all supervisory officials underground and all first-aid persons to keep first-aid equipment in good order and replenished when necessary.

25.2.3.6. All first-aid supplies should be stored in suitable, sanitary, dust-tight, moisture-proof containers and such supplies shall be accessible to the workers.

25.2.3.7. A list of all first-aid persons employed below ground should be kept posted in the first-aid centre and at places where it can easily be read by persons employed at the mine.

### 25.2.4. Transportation of sick or injured persons

25.2.4.1. The mine manager should make suitable arrangements to effect the swift and comfortable transport of injured and sick persons to the surface of the mine.

25.2.4.2. The employer should make such arrangements as are necessary for the immediate transport of sick and injured workers to hospital, or to their homes.

25.2.4.3. At every shaft or opening in which injured persons are raised and where the cage is not large enough to permit a stretcher to be laid flat, at every shaft or staple where persons can only be raised in a cage, and at every sinking pit, there should be

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provided and used a suitable jacket or contrivances to prevent the aggravation of an injury.

### **25.2.5. Inspection**

25.2.5.1. National laws or regulations should specify the intervals at which all first-aid equipment and the ambulance organization should be inspected by a competent person appointed by the manager.

25.2.5.2. All defects and shortcomings should be remedied without delay.

### **25.2.6. Training and retraining**

25.2.6.1. (1) Where practicable, every new entrant to the coal-mining industry should be given training and instruction in vital life-saving techniques and the basics of first aid.

(2) Refresher courses should be held as necessary to keep such persons up to date with new techniques.

25.2.6.2. Holders of approved first-aid certificates should be retrained and re-examined as required by the competent authority.

25.2.6.3. The persons employed in the first-aid centre and providing first aid to workers underground should, in addition to obtaining other qualifications, receive such instruction and training as will enable them to undertake:

- (a) resuscitation and treatment for shock;
- (b) assessment and evaluation of wounds;
- (c) applying dressings;
- (d) assessment and evaluation of medical and surgical conditions;
- (e) removal of victims from energized equipment and rendering treatments for electrical shock and severe body burns;
- (f) emergency treatment and referral;

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- (g) simple record keeping;
- (h) management of multiple casualties;
- (i) use of all emergency equipment; and
- (j) storage and supply management.

### 25.2.7. Reporting of injuries

25.2.7.1. Every person who suffers an injury, however slight, should report for examination or treatment at the first-aid centre before leaving the mine and should receive adequate treatment and referral as necessary, even if the injury has been treated underground; a record of reported injuries should be kept in the first-aid centre.

### 25.2.8. Medical examinations

25.2.8.1. (1) Every person should be medically examined before commencing work at a mine.

(2) The examination should normally include a chest X-ray.

(3) Re-examinations of all employees should be carried out at intervals to be fixed by the competent authority.

(4) All employees should be provided with the opportunity to have frequent medical examinations to identify illnesses or injuries that may have been a result of occupational exposure. The type of medical examinations, which should include chest X-rays, and their frequency should be specified by national laws or regulations.

(5) The employer should provide, free of charge to all persons, all medical examinations required by this section.

25.2.8.2. Persons should be certified as medically fit before commencing work at a mine.

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25.2.8.3. Records of all medical examinations and the action taken thereon should be kept confidential and maintained at the medical facilities as determined by national laws or regulations.

25.2.8.4. No person should be employed on heavy work, whether underground or on the surface, that is likely to cause physical injury or is manifestly in excess of their strength.

### **25.3. Evacuation and rescue**

#### **25.3.1. Emergency evacuation**

25.3.1.1. As cited in section 25.1 and in the fire prevention and emergency response plan contained in Chapter 9, each employer should have in place, a mine emergency response plan to implement if emergencies arise at the mine. That plan should cover mine evacuations and include:

- (a) the establishment of individual responsibilities for administering actions identified to implement an emergency response;
- (b) the establishment of emergency communication systems, procedures and individual responsibilities for carrying out emergency communications;
- (c) a system in place to provide immediate notification to all persons affected by the emergency, including alarms in place which should be capable of being seen and heard by everyone affected;
- (d) a procedure to allow for the safe, orderly and immediate withdrawal of persons from the mine or area of danger, including training on emergency escape routes and procedures;
- (e) procedures in place to be followed by workers who remain to perform critical operations before they evacuate, which include:

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- (i) the selection of only those personnel who have received special training to respond to critical operations and mine emergencies, including mine fires and explosions;
- (ii) having procedures in place to ensure the locations are safe for persons who would not be immediately withdrawn; and
- (iii) having the personnel equipped with the necessary gas-detection equipment and other equipment or tools necessary to respond to the critical operation at hand;
- (f) providing persons with particular risks with the equipment necessary for escape, such as self-contained self-breathing devices;
- (g) a response team that is trained and equipped and immediately available to respond to fires or other hazards that create mine emergencies;
- (h) procedures to account for all workers after the emergency evacuation is complete; and
- (i) providing relevant information and training to all personnel, at all levels, including regular exercises in emergency prevention, preparedness and response procedures and periodic emergency drills.

#### **25.3.2. Mine rescue**

##### **25.3.2.1. General**

25.3.2.1.1. National laws or regulations should require, and each employer should have in place, a mine emergency response and rescue plan as cited in section 25.1 that would also address mine rescue. This should be a part of the fire prevention and emergency response plan contained in Chapter 9.

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25.3.2.1.2. The employers should provide and maintain, jointly or separately at convenient centres, adequate central rescue stations fully equipped for rescue work and for the training of rescue workers, unless stations, rendering equally effective service, are maintained by the individual employer and approved by the competent authority.

25.3.2.1.3. The radius of operation of a station should be determined by the competent authority.

25.3.2.1.4. Every rescue station should be placed under the immediate control of a competent official who has been fully trained in rescue work and has had a sufficient period of practical experience underground in a mine, as decided by the competent authority, and possesses such other qualifications as national laws or regulations specify.

25.3.2.1.5. Unless exempted by the competent authority:

- (a) the employer should affiliate the mine to a central rescue station, if one exists in the mining district, in such a manner as to acquire the right of calling for and obtaining the full services of the station at any time; and
- (b) every mine should be connected by telephone to its central rescue station, if one exists, or, if not, to other nearby mines maintaining their own rescue stations.

25.3.2.1.6. (1) Rescue workers in sufficient numbers should be prescribed by national laws or regulations.

(2) They should be maintained and organized either:

- (a) by the provision of a permanent rescue corps at the central rescue station, and of trained rescue workers at the mine; or
- (b) by the provision of rescue teams at the mine.

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25.3.2.1.7. Subject to any exemption which may be granted by the competent authority, a sufficient number of members of a permanent rescue corps should be continuously employed at the station, and be in constant residence there.

25.3.2.1.8. Effective arrangements should be made at every mine for summoning other rescue workers as soon as their services are required.

### **25.3.2.2. Selection of rescue workers**

25.3.2.2.1. The persons to be trained in mine rescue work should be carefully selected on the grounds of their physical fitness, temperament, powers of endurance and general suitability for the work and, in the case of miners to be trained to cooperate with the permanent rescue corps, also on the grounds of their knowledge of the layout of the mine.

25.3.2.2.2. Rescue workers should have had at least two years' working experience underground in a coalmine and hold an approved first-aid certificate.

25.3.2.2.3. Every rescue worker should be medically re-examined every 12 months and should not continue to act as such unless certified as fit.

### **25.3.2.3. Instruction and practice**

25.3.2.3.1. At every central rescue station, or other stations as required by the competent authority, there should be a sufficient number of competent instructors to train rescue workers.

25.3.2.3.2. Every person selected for training in rescue work should undergo courses of instruction and practices prescribed by the competent authority.

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25.3.2.3.3. Rescue workers who have been certified as efficient should periodically undergo further practice and instruction as prescribed or approved by the competent authority.

### 25.3.2.4. Rescue apparatus and equipment

25.3.2.4.1. At every central rescue station, and at all other stations approved by the competent authority, there should be provided and maintained in good order, and permanently ready for immediate use, such adequate and suitable rescue equipment as is specified by the competent authority.

25.3.2.4.2. Any accidents or dangerous occurrences resulting from the use of breathing apparatus, smoke helmets or the like should be reported to the competent authority.

25.3.2.4.3. (1) At every mine there should be provided and maintained a room or other suitable accommodation for rescue workers and equipment in accordance with national laws or regulations.

(2) Rescue equipment, except that required to be kept below ground by paragraph 21.10.3(b), should be stored in such a room or accommodation and not underground in the mine.

25.3.2.4.4. National laws or regulations should state the intervals at which inspections are to be made of accommodation, apparatus and equipment provided for rescue work, training and practice.

25.3.2.4.5. (1) At every mine there should be kept, in a form suitable for use by rescue workers and for training purposes, a sufficient number of clear and legible tracings of the general ventilation system.

(2) The tracings should show all doors, stoppings, air crossings, regulators and telephone stations.

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(3) The tracings should show the intake airways in a colour different from that of the return airways.

25.3.2.4.6. The code of signals for use in rescue work and training in each country should be uniform for all mines and approved by the competent authority.

### 25.3.2.5. Conduct of mine rescue work

25.3.2.5.1. (1) It should be the duty of the manager of every mine to make rules for the conduct of rescue work at that mine subject to those required by national laws or regulations and the competent authority.

(2) These rules should specify:

- (a) the duties to be performed by certain persons when rescue work is to be carried out;
- (b) the duties of the person (nominated by the manager or some other competent person) who is in charge on the surface of the mine;
- (c) that only duly authorized persons may enter the affected part of the mine; and
- (d) that the name of every person who enters the mine should be recorded.

25.3.2.5.2. A competent person appointed by the manager should ensure that sufficient rescue teams are organized and that the sets of breathing apparatus are tested in accordance with the requirements of the competent authority.

25.3.2.5.3. (1) As soon as practicable, a fresh-air base or bases should be established as near as is safe to the possibly irrespirable atmosphere.

(2) As far as practicable, there should be provided at each fresh-air base:

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- (a) two persons, one competent to maintain self-contained breathing apparatus, and the other competent in first aid;
- (b) a rescue team equipped with breathing apparatus and ready for service in an irrespirable atmosphere;
- (c) resuscitation apparatus and such other equipment as prescribed in national laws or regulations; and
- (d) telephone communication between the fresh-air base and the surface of the mine.

25.3.2.5.4. (1) No rescue team should go beyond a fresh-air base unless it has received clear instructions as to where it should go and what it should attempt.

(2) When the team is not familiar with the route to be taken, the plan supplied should clearly show that route.

(3) Wherever possible, a guide from the mine concerned, equipped with breathing apparatus (if trained and qualified to use the device) should accompany the rescue team.

25.3.2.5.5. (1) The leader of each rescue team should at all times give first priority to the safety of the team.

(2) Immediately before the team enters irrespirable atmosphere, the leader should ensure that each set of breathing apparatus is working safely and satisfactorily.

(3) While in irrespirable atmosphere the leader should regularly check the condition of each team member and of the apparatus.

## 26. Work organization

Where national laws, regulations and standards do not contain prescription or contain ineffective or outdated prescription as to work organization, this chapter provides guidance. The provisions outlined in this chapter should be used in conjunction with the proper application of a hazard identification, risk assessment and control process.

### 26.1. Job safety analysis

26.1.1. The employer, in consultation with workers and their representatives, should study the work process in order to determine the tasks that make up job or work operation. Each of those tasks should then be analysed to determine the hazards, assess the risks and devise suitable means for performing the tasks as safely as possible. Special attention should be given to maintenance tasks.

26.1.2. Where the job safety analysis does not identify suitable controls to protect workers' safety, the task should not be undertaken.

26.1.3. The results of this analysis should be used to write a set of safe work procedures (SWPs), listing the hazards, required work procedures, appropriate PPE and procedures to be followed in case of unusual circumstances or emergencies.

26.1.4. The SWPs applicable to each task should be readily available to the workers involved. They should be reviewed with each such worker or work crew assigned to the task before the first time they perform it, and frequently thereafter.

26.1.5. SWPs should be reviewed, and revised if necessary, whenever the task or its hazards change, when there is an accident involving the task and periodically.

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### **26.2. Work flow**

26.2.1. As part of the risk-assessment process, the employer, in consultation with workers and their representatives, should chart the flow of raw materials, intermediate and finished products, mobile equipment and workers in the course of operations, noting the hazards that pertain to each step. The results of this analysis should be used to design the overall work process to be as safe as practicable.

### **26.3. Work teams**

26.3.1. Work teams should be resourced adequately to undertake the job safely.

### **26.4. Persons working alone**

26.4.1. The employer should take appropriate measures for the protection of workers working alone or in isolation.

### **26.5. Admission of outside persons**

26.5.1. Any person not employed at a mine should not be allowed to enter the mine, unless permitted by the manager to do so and accompanied by a responsible person.

26.5.2. Every person who enters a mine, for whatever purpose, should comply with the provisions of national laws or regulations and with any instructions given by the manager, supervisory officials or the accompanying responsible person with a view to ensuring his or her safety and the safety of the workers and of the mine.

### **26.6. General duties and conduct**

26.6.1. All persons who observe any danger to life or limb or to the mine should:

- (a) in accordance with their competence, take immediate steps to remove the danger; or
- (b) where this is not possible, immediately warn persons in danger, advise them to withdraw, withdraw himself/herself and notify the nearest available supervisory official.

26.6.2. Persons should be immediately withdrawn from any place in which they are found to be in imminent and serious danger.

26.6.3. All underground employees should be acquainted with those means of egress to the surface which they may have to use.

26.6.4. Supervisory officials on an outgoing shift should inform the supervisory officials of the next oncoming shift of any dangers that require attention in the workings under their respective supervision.

26.6.5. All cases where persons are withdrawn from parts of a mine because of imminent danger, and certain other exceptional circumstances to be defined in national laws or regulations, should be notified forthwith to the competent authority.

26.6.6. (1) Persons with infirmities should be employed only on work at which they cannot endanger themselves or others.

(2) They should receive adequate instruction and training to permit them to work without danger.

26.6.7. All persons employed at a mine should obey any instruction given to them by an official of the mine who has responsibility for such instructions in matters of safety, health or welfare.

26.6.8. No person in a mine should obstruct or impede another person engaged in the proper performance of his or her duties.

26.6.9. Every person employed at a mine should behave in an orderly manner on the surface and underground, at all times.

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26.6.10. No person should work at a mine in a state of intoxication, as determined by an appropriate standard.

26.6.11. No person should take any alcoholic beverage or dangerous drug into the mine.

26.6.12. No person should sleep below ground.

26.6.13. (1) Suitable protective helmets provided by the employer should be worn by all persons who work below ground and on designated sites on the mine surface.

(2) The employer should also provide other protective equipment where necessary to protect the health and safety of the miners.

## **27. Safety and health committees**

Where national laws, regulations and standards do not contain prescription or contain ineffective or outdated prescription as to safety and health committees, this chapter provides guidance. The provisions outlined in this chapter should be used in conjunction with the proper application of a hazard identification, risk assessment and control process.

### **27.1. Mine safety and health committees**

27.1.1. At every coalmine, a safety and health committee consisting of representatives of workers and the employer should be established and should meet regularly and whenever necessary to discuss all aspects of safety and health at the mine.

27.1.2. The employer should provide the safety and health committee with the facilities, training and assistance necessary to perform its functions, including all necessary safety and health information required for committee representatives.

27.1.3. The employer should notify the safety and health committee:

- (a) as soon as practicable, of any occupational accident or serious incident at the mine; and
- (b) in good time, of any inspection or investigation by the labour inspectorate at the mine regarding which the employer has received advance notice.

27.1.4. National laws or regulations should specify the powers and functions of safety and health committees.

### **27.2. Industry tripartite committees**

27.2.1. A tripartite committee should be established, consisting of representatives of employers, workers and the competent authority, which should meet regularly to consider all aspects of coalmine safety and health.

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27.2.2. The tripartite committee should:

- (a) consider relevant safety and health trends, technology developments and scientific and medical research at both the national and international levels;
- (b) advise the competent authority on safety and health at coalmines;
- (c) promote a national preventative safety and health culture, which is one in which the right to a safe and healthy working environment is respected at all levels, where governments, employers and workers actively participate in securing a safe and healthy working environment through a system of defined rights, responsibilities and duties, and where the principle of prevention is accorded the highest priority. Building and maintaining a preventative safety and health culture requires making use of all available means to increase general awareness, knowledge and understanding of the concepts of hazards and risks and how they may be prevented or controlled; and
- (d) recommend action on any safety or health matter which gives it cause for concern.

27.2.3. The competent authority should provide the tripartite committee with the necessary information required to perform its functions.

27.2.4. The powers and functions of the tripartite committee should be determined by agreement between the competent authority, employers and workers' representatives, or by national laws or regulations.

## 28. Special protection

Where national laws, regulations and standards do not contain prescription or contain ineffective or outdated prescription as to special protection, this chapter provides guidance. The provisions outlined in this chapter should be used in conjunction with the proper application of a hazard identification, risk assessment and control process.

### 28.1. Social protection

28.1.1. In accordance with national laws and regulations workers should:

- (a) be protected by a safety and health policy determined by agreement between the employers and workers;
- (b) be entitled to adequate workers' compensation in the event of an occupational injury or disease and be entitled to survivors' and dependants' benefits; and
- (c) have access to appropriate services for rehabilitation and return to work.

### 28.2. Working hours

28.2.1. Daily and weekly working hours should be arranged so as to provide adequate periods of rest which, as prescribed by national laws and regulations or approved by labour inspectorates or collective agreements, where applicable, should include:

- (a) short breaks during working hours, especially when the work is strenuous, dangerous or monotonous, to enable workers to recover their vigilance and physical fitness;
- (b) sufficient breaks for meals;
- (c) daily or nightly rest; and
- (d) weekly rest.

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28.2.2. Extended workdays (above eight hours) should be contemplated only if:

- (a) the nature of the work and the workload permit; and
- (b) the shift system is designed to minimize the accumulation of fatigue.

28.2.3. Any changes in work schedules that could affect occupational safety and health should be preceded by consultation with the workers and their representatives.

### **28.3. Carrying of matches, smokers' materials and lighters, and search for prohibited articles**

28.3.1. In all underground coalmines:

- (a) it should be prohibited to smoke or to bring in pipes, tobacco for smoking, cigarette papers, matches, or any other device or material capable of producing a flame, or any tool capable of being used to improperly open a flame safety lamp;
- (b) the manager should cause either all persons who enter a mine, or such of them as may be selected on a system approved by the competent authority, to be searched to see whether they are carrying any object prohibited by paragraph 28.3.1(a); and
- (c) any person who refuses to allow himself/herself to be searched should be refused entry into the mine.

28.3.2. Smoke-free workplace policies should be encouraged, in consultation with workers and their representatives, for other enclosed areas of the mine site. These policies should be implemented and enforced by the employer in compliance with applicable laws and regulations.

### **28.4. Alcohol- and drug-related problems**

28.4.1. Alcohol- and drug-related problems should be dealt with in the same way as any other health problem at work. The ILO

code of practice *Management of alcohol- and drug-related issues in the workplace*, 1996, deals specifically with this issue.

28.4.2. Alcohol and drug policies and programmes should promote the prevention, reduction and management of alcohol- and drug-related problems in the workplace. Employers and workers and their representatives should cooperate in developing such programmes for the facility.

28.4.3. The same restrictions or prohibitions with respect to alcohol should apply to both management personnel and workers.

28.4.4. Testing of bodily samples for alcohol and drugs in the context of employment involves moral, ethical and legal issues of fundamental importance, requiring a determination of when it is fair and appropriate to conduct such testing.

28.4.5. Workers who seek treatment and rehabilitation for alcohol- or drug-related problems should not be disciplined or discriminated against by the employer and should enjoy normal job security. Any information communicated should be treated with confidentiality.

28.4.6. It should be recognized that the employer has authority to discipline workers for employment-related misconduct associated with alcohol and drugs. However, counselling, treatment and rehabilitation should be preferred to disciplinary action.

## **28.5. HIV/AIDS**

28.5.1. HIV/AIDS should be treated like any other serious illness/condition in the workplace.

28.5.2. The ILO code of practice *HIV/AIDS and the world of work*, 2001, should be instrumental in helping to prevent the spread of the epidemic, mitigate its impact on workers and their families and provide social protection to help cope with the disease. The

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*HIV/AIDS guide for the mining sector, 2004*, published by Golder Associates for the International Finance Corporation, should also provide practical guidance in developing and implementing an organizational response to HIV/AIDS.

28.5.3. The work environment should be healthy and safe in order to prevent transmission of HIV. Employers should take steps to prevent the transmission of HIV and other blood-borne pathogens, particularly with respect to emergency response. Universal precaution should be applied with respect to first aid and other medical procedures and to the handling of other potentially infected material.

28.5.4. There should be no disciplinary action nor discrimination against workers on the basis of real or perceived HIV status.

28.5.5. In workplaces, it is recommended to have an HIV/AIDS policy and programme, the successful implementation of which requires cooperation and trust between employers, workers and their representatives.

28.5.6. There should be no discrimination against workers with HIV/AIDS in access to and receipt of benefits from statutory social security programmes and occupational health services.

## 29. Personal hygiene

Where national laws, regulations and standards do not contain prescription or contain ineffective or outdated prescription as to personal hygiene, this chapter provides guidance. The provisions outlined in this chapter should be used in conjunction with the proper application of a hazard identification, risk assessment and control process.

### 29.1. Facilities

29.1.1. The employer should provide adequate washing facilities, including hot and cold or warm running water, together with soap or other cleaning materials and towels or other appropriate drying arrangements.

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

29.1.3. Suitable toilets above and below ground should be provided by the employer.

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

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

29.1.6. 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.

29.1.7. 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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29.1.8. 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.

29.1.9. Floors should be slip-resistant and well drained.

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

29.1.11. Safe drinking water should be provided and be readily accessible to all workers.

## Bibliography

The International Labour Conference has adopted a large number of international labour Conventions and accompanying Recommendations directly concerned with OSH issues. The ILO has also developed codes of practice and technical publications that are applicable to underground coalmining. They represent a body of definitions, principles, obligations, duties and rights, as well as technical guidance reflecting the consensual views of the ILO's tripartite constituents from its 181 member States on most aspects of OSH.

### 1. Relevant ILO Conventions and Recommendations

#### 1.1. Fundamental ILO Conventions and accompanying Recommendations

Eight Conventions were included by the International Labour Conference in the ILO Declaration on Fundamental Principles and Rights at Work. These eight Conventions cover the following four areas.

##### Freedom of association

- Freedom of Association and Protection of the Right to Organise Convention, 1948 (No. 87)
- Right to Organise and Collective Bargaining Convention, 1949 (No. 98)
- The elimination of forced labour
- Forced Labour Convention, 1930 (No. 29)
- Abolition of Forced Labour Convention, 1957 (No. 105)

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The abolition of child labour

- Minimum Age Convention (No. 138) and Recommendation (No. 146), 1973
  - Worst Forms of Child Labour Convention (No. 182) and Recommendation (No. 190), 1999
  - The elimination of discrimination
  - Discrimination (Employment and Occupation) Convention (No. 111) and Recommendation (No. 111), 1958
  - Equal Remuneration Convention (No. 100) and Recommendation (No. 90), 1951
- 1.2. Conventions and Recommendations on occupational safety and health and working conditions
- Labour Inspection Convention, 1947 (No. 81)
  - Radiation Protection Convention (No. 115) and Recommendation (No. 114), 1960
  - Reduction of Hours of Work Recommendation, 1962 (No. 116)
  - Guarding of Machinery Convention (No. 119) and Recommendation (No. 118), 1963
  - Employment Injury Benefits Convention (No. 121) and Recommendation (No. 121), 1964
  - Maximum Weight Convention (No. 127) and Recommendation (No. 128), 1967
  - Workers' Representatives Convention, 1971 (No. 135)
  - Occupational Cancer Convention (No. 139) and Recommendation (No. 147), 1974
  - Working Environment (Air Pollution, Noise and Vibration) Convention (No. 148) and Recommendation (No. 156), 1977
  - Occupational Safety and Health Convention (No. 155) and Recommendation (No. 164), 1981

## Bibliography

- Protocol of 2002 (recording and notification of occupational accidents and diseases) to the Occupational Safety and Health Convention, 1981 (No. 155)
  - Occupational Health Services Convention (No. 161) and Recommendation (No. 171), 1985
  - Chemicals Convention (No. 170) and Recommendation (No. 177), 1990
  - Night Work Convention (No. 171) and Recommendation (No. 178), 1990
  - Prevention of Major Industrial Accidents Convention (No. 174) and Recommendation (No. 181), 1993
  - Safety and Health in Mines Convention (No. 176), 1995
  - Maternity Protection Convention (No. 183) and Recommendation (No. 191), 2000
  - List of Occupational Diseases Recommendation, 2002 (No. 194)
2. Selected ILO codes of practice with provisions which are relevant and applicable to the underground coalmining industry
- *Protection of workers against noise and vibration in the working environment*, 1977
  - *Safety and health in coal mines*, 1986
  - *Safety, health and working conditions in the transfer of technology to developing countries*, 1988
  - *Prevention of major industrial accidents*, 1991
  - *Safety in the use of chemicals at work*, 1993
  - *Management of alcohol- and drug-related issues in the workplace*, 1996
  - *Recording and notification of occupational accidents and diseases*, 1996

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- *Protection of workers' personal data*, 1997
- *Ambient factors in the workplace*, 2001
- *HIV/AIDS and the world of work*, 2001

### 3. Relevant publications

International Finance Corporation. 2004. *HIV/AIDS guide for the mining sector* (Washington, DC).

ILO. 1998. Declaration on Fundamental Principles and Rights at Work and its Follow-up, International Labour Conference, 86th Session (Geneva).

— . 1998. *Encyclopaedia of occupational health and safety*, 4th edition (Geneva) (four-volume print version and CD-ROM).

— . 1998. *Technical and ethical guidelines for workers' health surveillance*, Occupational Safety and Health Series, No. 72 (Geneva).

— . 2001. *Guidelines on occupational safety and health management systems, ILO-OSH 2001* (Geneva).

— . 2003. *Global strategy on occupational safety and health*, conclusions adopted by the International Labour Conference (Geneva).

United Nations. 2003. *Globally harmonized system of classification and labelling* (Geneva).

## Annex I

**Workers' health surveillance** (adapted from the ILO *Technical and ethical guidelines for workers' health surveillance*, 1998)

### 1. General principles

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

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

- (a) with the central purpose of primary prevention of occupational and work-related injuries and diseases;
- (b) under controlled conditions and within an organized framework, as may be prescribed by national laws and regulations and in accordance with the Occupational Health Services Convention, 1985 (No. 161), and Recommendation, 1985 (No. 171), and the ILO *Technical and ethical guidelines for workers' health surveillance*, Occupational Safety and Health Series, No. 72 (Geneva, 1998).

### 2. Organization

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

- (a) the need for a thorough investigation of all work-related factors and the nature of occupational hazards and risks in the workplace which may affect workers' health;
- (b) the health requirements of the work and the health status of the working population;
- (c) the relevant laws and regulations and the available resources;

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- (d) the awareness of workers and employers of the functions and purposes of such surveillance;
- (e) the fact that surveillance is not a substitute for monitoring and control of the working environment.

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

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

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

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

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

### 3. Assessment

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

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

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

- (a) collect information which serves as a baseline for future health surveillance;

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- (b) be adapted to the type of work, vocational fitness criteria and workplace hazards.

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

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

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

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

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

## 4. Collection, processing, communication and use of data

4.1. Workers' personal medical data should:

- (a) be collected and stored in conformity with medical confidentiality, in accordance with the ILO code of practice *Protection of workers' personal data*, 1997;

- (b) be used to protect the health of workers (physical, mental and social well-being) individually and collectively, in accordance with the ILO *Technical and ethical guidelines for workers' health surveillance*.

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

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

## **Annex II**

### **Surveillance of the working environment**

(according to the Occupational Health Services Recommendation, 1985 (No. 171))

1. The surveillance of the working environment should include:
  - (a) identification and evaluation of the hazards and risks which may affect the workers' safety and health;
  - (b) assessment of conditions of occupational hygiene and factors in the organization of work which may give rise to hazards or risks to the safety and health of workers;
  - (c) assessment of collective and personal protective equipment;
  - (d) assessment where appropriate of exposure of workers to hazardous agents by valid and generally accepted monitoring methods;
  - (e) assessment of control systems designed to eliminate or reduce exposure.
2. Such surveillance should be carried out in liaison with the other technical services of the undertaking and in cooperation with the workers concerned and their representatives in the undertaking and/or the safety and health committee, where they exist.
3. In accordance with national law and practice, data resulting from the surveillance of the working environment should be recorded in an appropriate manner and be available to the employer, the workers and their representatives in the undertaking concerned or the safety and health committee, where it exists.
4. These data should be used on a confidential basis and solely to provide guidance and advice on measures to improve the working environment and the safety and health of workers.

5. The competent authority should have access to this data. It may only be communicated to others with the agreement of the employer and the workers or their representatives in the undertaking or the safety and health committee, where it exists.

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

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

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

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

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

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

## Annex III

### Establishing an OSH management system

(adapted from the ILO *Guidelines on occupational safety and health management systems, ILO-OSH 2001*)

#### 1. Introduction

1.1. The positive impact of introducing occupational safety and health (OSH) management systems at the enterprise level, both on the reduction of hazards and risks and on productivity, is now recognized internationally by governments, employers and workers. The mutual benefits that accrue from the introduction of such systems should not be ignored if progress on improving safety and health and productivity in underground coalmines is to be achieved.

While systems need to be specific to an underground coalmine and appropriate to the size and nature of activities, many elements of the ILO-OSH 2001 guidelines are generic and assistance from other industry sectors should not be difficult to obtain when implementing such a system. The design and application of OSH management systems at national and facility levels for underground coalmining should be guided by the ILO *Guidelines on occupational safety and health management systems, ILO-OSH 2001*. The full text has not been reproduced in this condensed version.

#### 1.2. The competent authority should:

- (a) promote the implementation and integration of OSH management systems as an integral part of the overall management of underground coalmines;
- (b) elaborate national guidelines on the voluntary application and systematic implementation of OSH management systems based on the ILO *Guidelines on occupational safety and health management systems, ILO-OSH 2001*, or other internationally recognized

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safety and health management systems compatible with ILO-OSH 2001, taking into consideration national conditions and practice;

- (c) encourage the elaboration by authorized institutions of specific (tailored) guidelines on OSH management systems in underground coalmines;
- (d) provide support and technical guidance to labour inspectorates, OSH services and other public or private services, agencies and institutions dealing with OSH, including health-care providers;
- (e) ensure that guidance is provided to employers and workers to assist them to comply with their legal obligations under the policy;
- (f) ensure cooperation between employers whenever two or more facilities engage in activities on the same project;
- (g) recognize the need, so long as the safety and health of workers are not compromised, to protect confidential information that could potentially cause harm to an employer's business.

1.3. With a view to developing, implementing and operating OSH management systems, employers should:

- (a) set out in writing their respective OSH policy, programmes and safety and health protection arrangements as part of the general facility management policy;
- (b) define the various safety and health responsibilities, accountability and authority levels and communicate these clearly to their workers, visitors or any other persons working in the facility, as appropriate;
- (c) ensure effective arrangements for the full participation of workers and their representatives in the fulfilment of the OSH policy;
- (d) define both the necessary OSH competence requirements for all persons and the consequent individual training needs;

- (e) ensure workers have sufficient information, in a form and language that they understand, to protect their health from hazardous ambient factors;
- (f) establish and maintain appropriate documentation and communication arrangements;
- (g) identify the hazards and carry out assessments of the specific risks to safety and health of workers presented in the workplace;
- (h) establish hazard prevention and control measures including emergency prevention, preparedness and response arrangements;
- (i) establish procedures for compliance with OSH requirements in purchasing and leasing specifications and for contractors working on the site;
- (j) develop, establish and review procedures to monitor, measure and record OSH performance, taking into consideration the results of the investigations of work-related injuries and diseases, OSH compliance audits and reviews of the OSH system by management; and
- (k) identify and implement preventive and corrective actions and opportunities for continual improvement.

## 2. Occupational safety and health policy

2.1. The management of safety and health should be considered as a high priority management task. Consistent with the general policy of the underground coalmine, the employer should set out an OSH policy, which should:

- (a) be specific to the facility and appropriate to its size and the nature of its activities;
- (b) recognize OSH as an integral part of the overall management structure and OSH performance as an integral part of the business performance of the facility.

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2.2. The OSH policy should include, as a minimum, the following key principles and objectives to which the facility management is committed:

- (a) recognizing OSH as an integral part of the overall management structure and OSH performance as an integral part of the establishment's business performance;
- (b) protecting the safety and health of all members of the establishment by preventing work-related injuries, ill health, diseases and incidents;
- (c) complying with relevant OSH national laws and regulations, voluntary programmes, collective agreements on OSH and other requirements to which the establishment subscribes or may wish to subscribe;
- (d) ensuring that workers and their representatives are consulted and encouraged to participate actively in all elements of the OSH management system; and
- (e) continual improvement of the performance of the OSH management system.

2.3. The extent and precise nature of a safety and health policy will clearly depend on the size of the underground coalmine, but certain key components should be incorporated. These are:

- (a) the recruitment and training of personnel;
- (b) the identification of those personnel who have been assigned specific responsibilities in the area of safety and health;
- (c) the provision of equipment and substances in order to ensure a safe and healthy working environment;
- (d) arrangements for liaison with other concerned bodies, for example legislators, workers' organizations, public utilities such as water and electricity authorities, and organizations responsible for environmental conservation;

- (e) the function and constitution of the safety and health committee;
- (f) procedures for the enforcement of safety requirements adopted by the establishment whether by laws and regulations or otherwise;
- (g) procedures for the reporting of accidents, dangerous occurrences and occupational diseases;
- (h) the means by which the policy will be communicated to all those involved, including the date on which the policy will be reviewed and, as necessary, revised;
- (i) emergency procedures.

### **3. Worker participation**

3.1. Worker participation should be an essential element of the OSH management system in the facility. The employer should ensure that workers and their safety and health representatives are consulted, informed and trained on all aspects of OSH associated with their work, including emergency arrangements.

3.2. The employer should ensure, as appropriate, the establishment and efficient functioning of a safety and health committee and the recognition of workers' safety and health representatives, in accordance with national laws and practice. Safety and health committees should include workers or their representatives, employers' representatives and, where practicable, an occupational safety and health expert. Safety and health committees should meet regularly and participate in the decision-making process related to occupational safety and health-related issues.

### **4. Responsibility and accountability**

4.1. The employer should have overall responsibility for the protection of workers' safety and health and provide leadership for OSH activities and initiatives in the facility.

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4.2. The employer and senior management should allocate responsibility, accountability and authority among the personnel for the development, implementation and performance of the OSH management system and for OSH matters. These matters should constitute part of their overall responsibilities and be incorporated into job descriptions as part of management tasks. Measures should be taken to ensure that the personnel are competent and have the necessary authority and resources to perform their duties effectively.

4.3. Irrespective of the size and structure of the enterprise, senior managers should be appointed to develop, oversee and control safety and health standards. They should be the focal points to whom problems will be addressed, including the recording and notification of occupational accidents and diseases.

4.4. Managers and supervisory officials should:

- (a) implement the facility'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;
- (b) 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;
- (c) ensure that workers and contractors receive adequate information on safety and health regulations, policies, procedures and requirements, and satisfy themselves that this information is understood;
- (d) assign tasks to their subordinates in a clear and precise way. Managers and supervisory officials should satisfy themselves that workers understand and implement the safety and health requirements;
- (e) ensure that work is planned, organized and carried out in such a way as to minimize the risk of accidents and the exposure of

workers to conditions that may lead to injury or damage to their health.

4.5. In consultation with workers, managers and supervisory officials should assess the need for additional instruction, training or further education of workers by monitoring compliance with safety requirements.

4.6. Supervisory officials should be responsible for monitoring compliance by contractors and their workers with the requirements for occupational safety and health. In the event of non-compliance, supervisory officials should provide appropriate instruction and advice to contractors and their workers accordingly.

4.7. Workers should be made clearly aware of their rights and individual and collective duties for safety and health matters, as prescribed by national laws and regulations or adapted regulations of the facility.

4.8. Contractors employing workers in underground coalmines should be regarded as employers for the purposes of these guidelines, and the provisions pertaining to the responsibilities and duties of employers should apply accordingly.

4.9. Contractors and labour-supply agents should:

- (a) be registered or hold licences where required by national laws or regulations or subscribe to recognized voluntary schemes where they exist;
- (b) make themselves aware of, and operate according to, the commissioning parties' policies and strategies for the promotion of safety and health and should comply and cooperate with related measures and requirements.

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4.10. Contractors should comply with national laws and regulations concerning terms of employment, workers' compensation, labour inspection and occupational safety and health.

### **5. Competence and training**

5.1. The necessary OSH competence requirements should be defined by the employer, and appropriate training arrangements established and maintained to ensure that all persons are competent to perform their present or future safety and health duties and responsibilities.

### **6. Documentation**

6.1. According to the size and nature of activity of the facility, OSH management system documentation should be established and maintained, and may cover:

- (a) the OSH policy and objectives of the establishment;
- (b) the allocated key OSH management responsibilities of management, supervisory officials, workers and contractors for the implementation of the OSH management system;
- (c) the significant OSH hazards/risks arising from the activities of the facility, including a list of all hazardous substances in the workplace, and the arrangements for their prevention and control; and
- (d) arrangements, procedures, instructions or other internal documents concerning the safety and health of workers used within the OSH management system.

6.2. OSH records should be established, managed and maintained locally and according to the needs of the establishment. They should be identifiable and traceable, and their retention times should be specified.

6.3. OSH documentation should be available to all workers, workers' representatives, or other parties having an interest in or affected by its contents.

6.4. OSH records may include:

- (a) records arising from the implementation of the OSH management system;
- (b) records of work-related injuries, ill health, diseases and incidents, and relevant costs;
- (c) records arising from the implementation of national OSH laws or regulations;
- (d) records of workers' exposures, surveillance of the working environment and workers' health; and
- (e) the results of both active and reactive monitoring.

## **7. Communication and information**

7.1. Arrangements and procedures should be established and maintained for:

- (a) receiving, documenting and responding appropriately to internal and external communications related to OSH;
- (b) ensuring the internal communication of obligatory or other OSH information between relevant levels and functions of the enterprise in the management framework; and
- (c) ensuring that the concerns, ideas and inputs of workers and their representatives on OSH matters are received, considered and responded to.

7.2. In order to ensure the full integration of safety and health concerns into underground coalmining operations, guidelines on working practices or operations manuals should incorporate safety and health regulations and advice alongside provisions pertaining to quality, productivity, and environmental and other aspects.

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### **8. Initial review**

8.1. The existing OSH arrangements in a facility should be evaluated by an initial review, as appropriate. In the case where no formal OSH arrangements exist, or if the facility is newly established, an initial review should serve as a basis for establishing an OSH management system. Before conducting the review, three key questions should systematically be answered:

- (a) Where are we now?
- (b) Where do we want to be?
- (c) How do we get there?

8.2. In the context of an underground coalmine, an initial review in the form of an inventory survey should be completed by competent persons. The inventory or initial review should:

- (a) identify, quantify, locate or anticipate physical, chemical, biological and other hazards and assess risks to safety and health arising from the existing or proposed work environment and work organization; and
- (b) result in the creation of an inventory list of hazardous substances (wastes) and other substances.

8.3. Additional reviews, as appropriate, should:

- (a) identify the current applicable national laws and regulations, national guidelines, tailored guidelines, voluntary schemes and other requirements to which the establishment subscribes;
- (b) determine whether planned or existing controls are adequate to eliminate hazards or control risks; and
- (c) analyse other available data, in particular data provided from workers' health surveillance (see Annex I) and surveillance of the working environment (see Annex II).

8.4. The employer of the underground coalmine establishment should establish and maintain procedures to identify, evaluate systematically and record the hazards and risks to safety and health that may affect, or arise from coalmining activities.

## 9. System planning, development and implementation

9.1. Based on the results of the initial review, hazard identification and risk assessment and other available data, e.g. the results of workers' health surveillance (see Annex I), surveillance of the working environment (see Annex II), and active and reactive monitoring, the employer should:

- (a) define OSH objectives for the reduction of such risks to as low a level as possible;
- (b) devise and implement corresponding preventive measures, based on an appropriate order of prevention; and
- (c) develop, approve and implement a "safe coalmining plan" before any operation starts.

These activities should include the routine application of site inspection and planning as well as of the principles of work organization.

9.2. The planning arrangements should contribute to the improved protection of safety and health at work, and should include:

- (a) a clear definition, priority setting and quantification, where appropriate, of the OSH objectives of the establishment;
- (b) the preparation of a plan for achieving each objective, with defined responsibility and clear performance criteria indicating what is to be done by whom and when and what is the predicted result;
- (c) the selection of measurement criteria (indicators) for confirming that the objectives are achieved; and

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- (d) the provision of adequate resources, including human and financial resources and technical support, as appropriate.

9.3. Resource allocation should include, among others:

- (a) the facilities, tools and equipment required to meet legislative and other adopted standards;
- (b) an organized infrastructure to respond to and mitigate the effects of accident risks and health hazards;
- (c) availability of management for reviewing and auditing standards and practices;
- (d) assessment of future needs arising from new technical or legal developments.

## **10. Occupational safety and health objectives**

10.1. Consistent with the OSH policy, and based on the initial review, subsequent reviews and other available data, measurable OSH objectives should be established, which are:

- (a) specific to the facility, and appropriate to and according to its size and nature of activity;
- (b) consistent with the relevant and applicable national laws and regulations, and the technical and business obligations of the facility with regard to OSH;
- (c) focused towards continually improving workers' OSH protection to achieve the best OSH performance;
- (d) realistic and achievable;
- (e) agreed with those who deliver them;
- (f) set against a suitable timescale;
- (g) documented, and communicated to all relevant functions and levels of the enterprise; and
- (h) periodically evaluated and, if necessary, updated.

## 11. Hazard identification and risk assessment, preventive and protective measures

11.1. Employers should make arrangements for the identification and periodic assessment of the hazards and risks to safety and health from hazardous ambient factors at each permanent or temporary workplace, generated by the use of different operations, tools, machines, equipment and substances.

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

11.3. For works which by their very nature expose workers to hazards arising from the use or presence of hazardous chemical, physical or biological factors, psychosocial factors and climatic conditions, appropriate preventive and protective measures should be implemented to prevent those hazards and risks, or to reduce them to the lowest reasonable and practicable level, in conformity with national laws and regulations.

11.4. The employer should take appropriate measures for the prevention and control of, and protection against, occupational hazards in the working environment.

11.5. Hazards and risks to workers' safety and health should be identified and assessed on an ongoing basis. Preventive and protective measures should be implemented in the following order of priority:

- (a) eliminate the hazard/risk;
- (b) control the hazard/risk at source, through the use of engineering controls or organizational measures;

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- (c) minimize the hazard/risk by the design of safe work systems, which include administrative control measures; and
- (d) where residual hazards/risks cannot be controlled by collective measures, the employer should provide for appropriate PPE, including clothing, at no cost, and should implement measures to ensure its use and maintenance.

### **Management of change**

11.6. The impact on OSH of internal changes (e.g. those in staffing or due to new processes, working procedures, organizational structures or acquisitions) and of external changes (e.g. as a result of amendments of national laws and regulations, organizational mergers, and developments in OSH knowledge and technology) should be evaluated and appropriate preventive steps taken prior to the introduction of changes.

11.7. A workplace hazard identification and risk assessment should be carried out before any modification or introduction of new work methods, materials, processes or machinery.

### **Procurement**

11.8. Procedures should be established and maintained to ensure that:

- (a) compliance with safety and health requirements for the establishment is identified, evaluated and incorporated into purchasing and leasing specifications;
- (b) national laws and regulations and the own OSH requirements of the establishment are identified prior to the procurement of goods and services; and
- (c) arrangements are made to achieve conformance with the requirements prior to their use.

## Contractors

11.9. Arrangements should be established and maintained for ensuring that the safety and health requirements of the facility, or at least the equivalent, are applied to contractors and their workers.

## 12. Performance monitoring and measurement

12.1. Safety and health performance should be monitored against predetermined plans and standards and underground coalmining enterprises should measure what they are doing to implement their safety and health policy and to assess how effectively they are controlling risks. Monitoring should reinforce management's commitment to safety and health objectives and help in developing and promoting a positive safety and health culture.

12.2. Monitoring should provide:

- (a) feedback on OSH performance;
- (b) information to determine whether the day-to-day arrangements for hazard and risk identification, prevention and control are in place and operating effectively; and
- (c) the basis for decisions about improvement in hazard identification and risk control, and the OSH management system.

12.3. *Active monitoring* should contain the elements necessary to have a proactive system and should include:

- (a) monitoring of the achievement of specific plans, established performance criteria and objectives;
- (b) the systematic inspection of work systems, premises and equipment;
- (c) surveillance of the working environment (see Annex II), including work organization;
- (d) surveillance of workers' health (see Annex I), where appropriate, through suitable medical monitoring or follow-up of workers for

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early detection of signs and symptoms of harm to health in order to determine the effectiveness of preventive and protective measures; and

- (e) compliance with applicable national laws and regulations, collective agreements and other commitments on OSH to which the establishment subscribes.

12.4. *Reactive monitoring* should include the identification, reporting and investigation of:

- (a) work-related injuries, ill health (including monitoring of aggregate sickness absence records), diseases and incidents;
- (b) other losses, such as damage to property;
- (c) deficient safety and health performance, and OSH management system failures; and
- (d) workers' rehabilitation and health-restoration programmes.

### 13. Investigation of work-related injuries, ill health, diseases and incidents, and their impact on safety and health performance

13.1. Underground coalmining facilities should investigate and document the origin and underlying causes of all work-related injuries, ill health, diseases and incidents to identify any failures in the OSH management system.

13.2. Such investigations should be carried out by identified competent persons (internal or external) along with the appropriate participation of workers and their representatives. All investigations should conclude with a report on the action taken to prevent a recurrence.

13.3. The results of all investigations should be communicated to the worker(s) involved and the safety and health committee, where it exists, to make any appropriate recommendations.

13.4. The results of investigations, in addition to any recommendations from the safety and health committee, should be communicated to:

- (a) appropriate persons for corrective action, included in the management review and considered for continual improvement activities; and
- (b) the competent authority, if so required by national laws and regulations.

13.5. Corrective action resulting from investigations should be implemented, and subsequently checked in order to avoid repetition of the work-related injuries, ill health, diseases and incidents which gave rise to the investigation.

13.6. Reports produced by external investigation agencies, such as inspectorates and social insurance institutions, should be acted upon in the same manner as internal investigations, taking into account issues of confidentiality.

## **14. Audit**

14.1. Arrangements to conduct periodic audits are to be established in order to determine whether the OSH management system and its elements are in place, adequate, and effective in protecting the safety and health of workers and preventing incidents.

14.2. The audit should evaluate all elements of the facility's OSH management system or a subset of these, as appropriate. Its conclusion should determine whether the implemented OSH management system elements or subset:

- (a) are effective in meeting the OSH policy and objectives of the facility;
- (b) are effective in promoting full worker participation;

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- (c) respond to the results of OSH performance evaluation and previous audits;
- (d) enable the facility to achieve compliance with relevant national laws and regulations; and
- (e) fulfil the goals for continual improvement and best OSH practice.

14.3. Consultation on selection of the auditor and all stages of the workplace audit, including analysis of results, are subject to worker participation, as appropriate.

## **15. Management review**

15.1. A management review should:

- (a) evaluate the overall strategy of the OSH management system to determine whether it meets planned performance objectives;
- (b) evaluate the OSH management system's ability to meet the overall needs of the establishment and its stakeholders, including its workers and the regulatory authorities;
- (c) identify what action is necessary to remedy any deficiencies in a timely manner, including adaptations of other aspects of the management structure and performance measurement of the establishment.

15.2. The findings of a management review should be recorded and formally communicated to:

- (a) the persons responsible for the relevant element(s) of the OSH management system so that they may take appropriate action; and
- (b) the safety and health committee, workers and their representatives.

## **16. Preventive and corrective action**

16.1. Arrangements should be established and maintained for preventive and corrective action resulting from OSH management system performance monitoring and measurement, OSH management system audits and management reviews.

16.2. When the evaluation of the OSH management system or other sources show that preventive and protective measures for hazards and risks are inadequate or likely to become inadequate, the measures should be addressed according to the recognized hierarchy of preventive and protective measures, and completed and documented, as appropriate and in a timely manner.

## **17. Continual improvement**

17.1. Arrangements should be established and maintained for the continual improvement of the relevant elements of the OSH management system and the system as a whole. The safety and health processes and performance of the facility should be compared with others in order to improve safety and health performance.

## **Annex IV**

### Occupational exposure limits for hazardous substances, heat, noise and vibration

#### 1. Purpose

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

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 annex.

#### 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

should be taken into account if they are used. For example, some 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. 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.

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

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2.4. 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.

2.5. 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 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  $\text{mg}/\text{m}^3$  (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  $\text{mg}/\text{m}^3$  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 inhalation to*

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*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 2.2 of this annex).

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. Heat

5.1. 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.

5.2. 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.

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

5.4. The ACGIH publication *Threshold limit values for chemical substances and physical agents and biological exposure indices* (see paragraph 2.2 of this annex) gives details of work/rest regimes and is revised annually.

## 6. Noise

6.1. 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 recognized by the competent authority. These include a series of ISO standards on acoustics (1999:1990; 4871:1996; 9612:1997; 7196:1995; 11690:1996).

## 7. Vibration

7.1. 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.

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7.2. 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).

7.3. 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).

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