International
Labour
Office

Geneva

Safety and health in opencast mines

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Second (revised) edition

ILO code of practice

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INTERNATIONAL LABOUR OFFICE • GENEVA

First published 1991

Second (revised) edition 2018

ILO code of practice: Safety and health in opencast mines. International Labour Office, Geneva, 2018

ISBN 978-922-131709-8 (print)

ISBN 978-922-131710-4 (web pdf)

Also available in French: *La sécurité et la santé dans les mines à ciel ouvert*. Recueil de directives pratiques du BIT, ISBN 978-92-2-231120-0 (print); ISBN 978-92-2-231121-7 (web pdf); and in Spanish: *Seguridad y salud en las minas a cielo abierto: Repertorio de recomendaciones prácticas de la OIT*, ISBN 978-92-2-328553-1 (print); ISBN 978-92-2-328554-8 (web pdf), Geneva, 2018.

This publication was produced by the Document and Publications Production, Printing and Distribution Branch (PRODOC) of the ILO.

Graphic and typographic design, layout and composition, proofreading, printing, electronic publishing and distribution.

PRODOC endeavours to use paper sourced from forests managed in an environmentally sustainable and socially responsible manner.

Code: DTP-CORR-SCR-REP

Preface

The ILO Code of practice on safety and health in opencast mines was adopted by a Meeting of Experts held in Geneva from 16 to 20 October 2017, in accordance with a Governing Body decision at its 329th Session (March 2017). This code of practice replaces an earlier code that was adopted in 1990. The meeting was attended by 22 experts and their advisers - eight experts nominated by the Governments of Canada, Chile, Germany, Indonesia, Mongolia, Namibia, Russian Federation and Zambia; seven nominated by the Employers' group of the Governing Body; and seven nominated by the Workers' group of the Governing Body. Expert observers from other governments, and observers from intergovernmental and non-governmental organizations, also attended the meeting.

The good spirit of cooperation among all participants paved the way for developing consensus on a new, comprehensive and practical code that will help to raise the profile of safety and health issues in opencast mines in all parts of the world, and contribute to the health, morale and well-being of workers in the industry.

The text of the code was approved for publication by the Governing Body of the ILO at its 332nd Session (March 2018).

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Sectoral codes of practice

ILO Sectoral codes of practice are reference tools setting out principles that can be reflected in the design and implementation of policies, strategies, programmes, legislation, administrative measures and social dialogue mechanisms in particular economic sectors or clusters of sectors. Sectoral codes of practice are adopted by Meetings of Experts comprising governments, employers and workers. They can be implemented progressively to take into account different national settings, cultures, and social, economic, environmental and political contexts.

Sectoral codes of practice draw their principles from the ILO's international labour standards (Conventions and Recommendations) and other sources, including Declarations, codes of conduct and other policy guidance adopted and endorsed by the International Labour Conference or the ILO Governing Body. They also draw on other international agreements and policy in the sector concerned, as well as on relevant trends and developments in regional and national law and practice.

Sectoral codes of practice focus on the issues that are priorities for governments, employers and workers, and that are unique to particular economic sectors and industries. While international labour standards normally deal with more general principles of labour law and practice, Sectoral codes of practice specify the principles and processes that could be implemented to promote decent work in particular workplaces or contexts. They benefit from the expertise of practitioners in the relevant sectors to capture good industry practices and innovations.

Sectoral codes of practice are not legally binding. They are not subject to ratification or supervisory mechanisms established

under the ILO's international labour standards. Sectoral codes of practice can therefore be aspirational in scope and expand on principles laid down in international labour standards and other international agreements and policy, all the while recognizing that they can be adapted to different national systems and circumstances. As such, ILO standards and other tools or guidance adopted and endorsed by the International Labour Conference and/or the Governing Body form the foundation on which Sectoral codes of practice build further. It is therefore understood that Sectoral codes of practice are based on the full principles, rights, and obligations set out in international labour standards, and nothing set out in these codes of practice should be understood as lowering such standards.

Contents

Abbreviations and definitions

In this code of practice ("code"), the following terms are used in the meaning assigned to them below:

Accepted standard: A national or international standard accepted and promulgated by a nationally recognized standards organization.

Approved: Accepted or permitted by a competent authority for a specific purpose under national laws.

Authorized person: A person authorized by the employer in charge of the mine and who is competent for the work they are required to perform.

Berm: A pile or mound of material placed for the purpose of effectively restraining a vehicle or catching falling rocks or material.

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 to monitor and regulate the various aspects of safety and health in opencast mines.

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

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.

Dredge: A water-borne craft fitted with an excavator, which breaks up the material to be won, in or under water.

Dump: see *Tip*.

Electrical equipment: Includes electric cables and any part of any machinery, equipment or appliance being a part designed for the generation, conversion, storage, transmission or utilization of electricity.

Employer: The term employer means any physical or legal person who employs one or more workers in a mine and, as the context requires, the operator, the principal contractor, contractor or subcontractor.

Excavator: A machine which may be further identified as a single or a multi-bucket, fitted with devices for breaking up, loading, transporting and dumping materials without lateral movement of the whole machine.

Explosive: Any substance or blasting agent which may be defined as such by national laws or classified as such by a competent authority.

FAO: Food and Agriculture Organization of the United Nations.

Hazard: The inherent potential to cause illness or injury.

IAEA: International Atomic Energy Agency.

Insulated: Separated from other conducting surfaces by a dielectric substance permanently offering a high resistance to the passage of current and to disruptive discharge through the substance; for purposes of the present definition, it is to be understood that the manner of insulation is such that it is suitable for the conditions to which it will be subjected under normal usage.

Isolated: Disconnected from the normal source of energy.

Live: Electrically energized.

Machinery code: The ILO code of practice *Safety and health in the use of machinery* (Geneva, ILO, Programme on Safety and Health at Work and the Environment, 2013).

Mill: Includes any ore mill, sampling works, concentrator, and any crushing, grinding or screening plant used at, and in connection with, an opencast mine.

Mined material: Material removed from the earth to directly produce a saleable product, not including overburden.

Misfire: An occurrence in relation to the firing of shots where testing before firing reveals broken continuity which cannot be rectified, or a shot or any part of a shot fails to explode when an attempt is made to fire it.

National laws: Includes laws of federated states, regulations and administrative instruments made under those laws.

OECD: Organisation for Economic Co-operation and Development.

OSH: Occupational safety and health.

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

Opencast mine: Includes surface mines, open-cut mines, open-pit mines and strip mines. It denotes a place where rock or other material is removed from its natural place of formation or deposition while working on the surface. It includes infrastructure directly related to such removal, treatment and handling for transport. A surface mine also includes any building, construction, dump, dam, machinery and appliance situated at or near the mine and used for any purpose necessary or incidental to the winning and subsequent treatment of the products of the mine. The waste material emanating therefrom is considered to form part of such mine unless a line of demarcation excluding any part has been agreed by the competent authority. The term excludes facilities for oil and gas production. The competent

authority may make laws to define places which are to be considered to be opencast mines and to which laws relating to safety and health at mines apply.

Overburden: The rock, earth, together with other unconsolidated material or other matter lying on or interspersed with the material to be won.

PAHO: Pan American Health Organization.

PPE: Personal protective equipment.

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

Risk assessment: The process of identifying, analysing and evaluating risks to safety and health arising from hazards at work for the purpose of control.

Rock: Any portion of the earth's crust, whether consolidated or not.

SDS: Safety data sheet.

Small mine: For the purposes of this code, a small mine is a formally operating mine which employs few people, with low levels of output and investment of capital, or as defined by the competent authority. To denote miners working in informal small-scale mines, typically characterized by low levels of mechanization and labour-intensive production processes, the term "artisanal and small-scale miners" (ASMers) is used in this code.

Tip: Any heap, pile or other location used for the disposal of solid discard material from an opencast mine or the plant and rock or soil from overburden removal. This includes waste dumps, but does not include tailings dams or lagoons (slurry ponds).

Training: Either training or education or a combination of the two. In specific areas, certification or licensing as evidence

of having received the necessary education and training may be a requirement.

Wheel assembly: Comprises a rim base, flanges, bead seat band, lock ring and wheel disc or nave plate welded to the rim base.

WHO: World Health Organization.

Worker 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 organization 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.

Working: A part of an opencast mine which is in the course of being excavated, and a part that has been excavated, whether abandoned or not.

Introduction

1. In accordance with the decision taken by the Governing Body of the ILO at its 329th Session in March 2017, a Meeting of Experts on Safety and Health in Opencast Mines ("the Meeting") was convened in Geneva from 16 to 20 October 2017 to review and adopt a revised code of practice *Safety and health in opencast mines*. The Meeting was composed of eight experts appointed following consultations with Governments, seven experts appointed following consultations with the Employers' group and seven experts appointed following consultations with the Workers' group of the Governing Body.

2. The original code of practice *Safety and health in opencast mines* was published in 1991. This revised code 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 (OSH), including the Safety and Health in Mines Convention, 1995 (No. 176). To this effect, the new code is based on the principles of the Convention, including risk assessment, addresses issues such as the interaction between large-scale and small-scale artisanal miners and also comprises a section on automated machinery, a development that has great potential to change the work carried out by nearly all workers in opencast mines worldwide.

3. Codes of practice are primarily designed as a basis for prevention, and protective and corrective measures and are considered as ILO technical standards in OSH. 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.

4. The first chapter of this code provides an overview of the code's purpose, objectives and use. The general duties of the stakeholders are outlined in the second chapter. Chapter 3 comprises guidance on the setting up of safety and health committees in mines, as well as industry tripartite committees on the national level. Chapters 4–8 outline fundamental principles, including on risk assessment and management, and the setting up of OSH management systems and emergency response. The code's Chapter 9 comprises descriptions of specific hazards, provides input into assessing risks and describes respective control measures. Chapter 10 deals with general controls; Chapter 11 with work organization. It is followed by Chapter 12 on special protection, which addresses issues including general welfare and HIV and AIDS.

1. General provisions

1.1. Purpose

5. The practical recommendations of this code are intended for the use of all those, in both the public and private sectors, who have rights, responsibilities and duties regarding safety and health in opencast mines.

6. The code addresses most of the currently identified hazards and risks associated with opencast mines; 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.

7. The purpose of this code is to provide practical guidance in support of the application and implementation 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.

8. 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 opencast mining.

9. The provisions of this code 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.

1.2. Objectives

10. This code should contribute to:

(a) protecting workers in opencast mines from workplace hazards and preventing or reducing work-related injuries and diseases, ill health and dangerous occurrences;

(b) assisting and facilitating the improved management of OSH issues at each workplace;

(c) promoting effective consultation and cooperation between governments, employers, workers and their organizations in the improvement of OSH in opencast mines;

(d) improved safety and health in the context of sustainable development; and

(e) the health and safety of local communities.

11. This code should assist in:

(a) establishing a coherent national policy and principles on OSH and the welfare of workers in opencast mines 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; and

(d) promoting the implementation and integration of consistent OSH management systems with a view to improving working conditions.

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

(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;

(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 workers' health;

(e) emergency procedures and first aid;

(f) the provision of information and training to workers; and

(g) the establishment of a system to record, report and monitor occupational accidents and diseases, and dangerous occurrences.

1.3. Application

13. This code, which is applicable to all opencast mines, should provide guidance, in accordance with the provisions of national laws and regulations, to:

(a) all government authorities, workers' and employers' organizations and industry associations, whether having legislative or advisory roles and whose activities influence the safety, health and welfare of workers in opencast mines;

(b) all those individuals at the level of the mine, that is, employers, persons in control of premises, and workers and contractors, as appropriate to their duties and responsibilities for safety and health.

14. A number of OSH measures implemented to protect workers' health and safety in opencast mines 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.

15. The provisions of this code are not intended to replace applicable laws, regulations or accepted standards. More stringent applicable requirements 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, as well as from other relevant nationally and internationally recognized instruments.

16. 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

17. In the establishment, implementation and review of policies and programmes on OSH in opencast mines under this code, competent authorities and employers' and workers' organizations should take into account ratified international labour standards and that the fundamental principles and rights at work apply to all workers and employers. They should also 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. General duties

2.1. Cooperation

18. This code recognizes that effective safety and health systems require 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 are achieved.

19. Measures for cooperation should be taken relating to the identification of hazards and the elimination or control of risks to safety and health from opencast 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, including providing relevant information about safety and health from the employer's suppliers and manufacturers;

(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 on request 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.

2.2. Competent authority

2.2.1. General provisions

20. The competent authority, 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, should:

(a) develop, maintain and control the application of laws and regulations on occupational safety and health in opencast mines and identify and incorporate accepted standards into these;

(b) devise and maintain a national policy on OSH, including the promotion of a systematic approach to OSH through OSH management systems in accordance with national laws and regulations; and

(c) consider making new, or updating existing, statutory provisions for the identification of hazards and the elimination or control of risks in opencast mines.

21. Statutory provisions should include national laws or regulations, codes of practice, exposure limits, standards of competency and training for all workers, and establish a process for consultation with and dissemination of information to employers, workers and their representatives.

22. 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 opencast mines 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 structures, facilities, machinery, equipment, processes and operations used in opencast mines.

23. 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.

24. The competent authority should ensure the enforcement of national laws and regulations concerning the policy mentioned above through an adequate and appropriate system of inspection. The system of enforcement should be developed through a consultative process involving employers' and workers' representatives.[1] The system of enforcement should provide for corrective measures and adequate penalties for violations of national laws and regulations concerning the policy.

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

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[1] 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 organization 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.

(a) prohibit or restrict the use of certain hazardous practices, processes or substances; or

(b) require advance notification and authorization before any such restricted practices, processes and substances are used; or

(c) without discrimination, 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.

26. 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.

2.2.2. Inspectorates

27. Inspectorates designated by the competent authority should, in a manner prescribed by national laws and regulations:

(a) enforce all relevant laws and regulations at opencast mines;

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

(c) assist employers, workers and their representatives with respect to their OSH responsibilities, duties and rights;

(d) monitor the safety and health requirements and performance of comparable national or international opencast mines 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 the national, enterprise and mine levels.

28. Inspectors should, in a manner prescribed by national laws and regulations:

(a) be competent to deal with the safety and health issues associated with opencast mines and be able to provide support and advice;

(b) have the authority to investigate fatal and serious accidents, dangerous occurrences and opencast 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, adequate and effective;

(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; and

(g) have access to all worker training records.

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

2.3. Employers' responsibilities and rights

30. In taking preventive and protective measures (control measures), subject to national laws and regulation, the employer should identify the hazard and assess the risk and deal with it in the following order of priority:

(a) eliminate the hazard;

(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 (PPE),

having regard to what is reasonable, practicable and feasible, and to good practice and the exercise of due diligence.[2]

31. Employers should take all reasonable, practicable and feasible measures to eliminate or minimize the risks to safety and health in opencast mines 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;

(d) 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;

[2] As required in Article 6 of the Safety and Health in Mines Convention, 1995 (No. 176).

(e) 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;

(f) take measures and precautions appropriate to the nature of a mine operation to prevent, detect and respond to the start and spread of fires and explosions;

(g) 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

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

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

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

(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.

34. 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 at the mine can be accurately known at any time, as well as their probable location;

(d) all accidents, occupational illnesses 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.

35. 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 opencast mining.

36. 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.

37. Multinational enterprises should maintain the highest standards of safety and health, in conformity with national requirements, bearing in mind their relevant experience within the enterprise as a whole, including any knowledge of special hazards. They should also make available to the representatives of the workers, and upon 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 relevant to their local operations, which they observe in other countries. In particular, they should make known to those concerned any special hazards and related protective measures associated with new products and processes. They, like comparable domestic enterprises, should be expected to play a leading role in the examination of causes of industrial safety and health hazards and in the application of resulting improvements within the enterprise as a whole.

2.4. Workers' rights and responsibilities

38. National laws and regulations should provide for that workers have the following rights and responsibilities:

(a) to report accidents, occupational illnesses, dangerous occurrences, near-miss events 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;

(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 without fear of repercussion or disciplinary measures 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.

39. National laws and regulations should provide for that safety and health representatives have the following rights and responsibilities:

(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.

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

41. National laws and regulations should provide for that workers have the duty, in accordance with their training:

(a) to comply with prescribed safety and health measures;

(b) to present themselves at work in a fit for work state and to inform the employer of any change in their fitness for work state;

(c) to take reasonable care for their own safety and health and that of other persons who may be affected by their acts or omissions at work, including the proper care and use of protective clothing, facilities and equipment placed at their disposal for this purpose;

(d) to report forthwith to their immediate supervisor any situation which they believe could present a risk to their safety or health or that of other persons, and which they cannot properly deal with themselves; and

(e) to cooperate with the employer to permit compliance with the duties and responsibilities placed on the employer, and to participate with the safety and health committee in the development and implementation of the occupational safety and health management system of the mine.

2.5. General responsibilities of suppliers, manufacturers and designers

42. Measures, including national laws and regulations, should be taken to ensure that those who design, manufacture, import, provide or transfer machinery, equipment or substances for use in opencast mines:

(a) ensure that the machinery, equipment or substances do not entail dangers for the safety and health of those using them correctly, and ensure that they meet appropriate and applicable standards or certification requirements; and

(b) make available:

(i) information concerning their requirements for the correct set up, use and maintenance of machinery and equipment and the correct use of substances;

(ii) information concerning the hazards of machinery and equipment, including the dangerous parts of machinery and hazardous components or equipment, 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.

Further information: ILO code of practice *Safety and health in the use of machinery* (2013).

2.6. General responsibilities and rights of contractors

43. Contractors should comply with the arrangements established by the employer in charge of the mine, which should:

(a) include the contractor performing a risk assessment, establishing risk controls for their work and submitting a workplan to the employer. The contractor should comply with the workplan and risk controls, and inform the employer of any changes;

(b) include OSH criteria in procedures for evaluating and selecting contractors;

(c) 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;

(d) include arrangements for reporting work-related injuries and diseases, ill health and dangerous occurrences among the contractor's workers while performing work for the mine;

(e) 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;

(f) regularly monitor OSH performance of contractor activities on-site; and

(g) ensure that on-site OSH procedures and arrangements are followed by the contractor(s).

44. When using contractors, the employer in charge of the mine should ensure that:

(a) contractors develop a safety and health plan in accordance with the mine OSH management system that is approved by the employer in charge of the mine prior to commencing work;

(b) the requirements of the OSH management system of the mine, including training requirements, apply to the contractors and their workers as they do to the workers in the establishment, including procedures to investigate accidents, occupational illnesses and dangerous occurrences;

(c) where required, only such contractors are used that have been duly registered or hold licences; and

(d) contracts specify safety and health requirements as well as sanctions and penalties in case of non-compliance. Contracts should include the right for supervisors mandated by the employer in charge of the mine to inspect work and to stop work whenever a risk of serious injury is apparent and to suspend operations until the necessary remedies have been put in place.

3. Safety and health committees

3.1. Safety and health committees

45. At every mine, 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.

46. 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, and to educate workers: (i) on their right to refuse unsafe work without fear of reprisals, (ii) their right to participate in all aspects of their safety and health, and (iii) their right to know how their work activities may affect their safety and health.

47. The employer should notify the safety and health committee:

(a) as soon as practicable, of any occupational accident, occupational disease or dangerous occurrences at the mine; and

(b) in good time of any inspection or investigation by the competent authority at the mine regarding which the employer has received advance notice.

48. National laws or regulations should specify the powers and functions of safety and health committees.

3.2. Industry tripartite committees

49. In accordance with national laws and regulations, 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 mining safety and health.

50. 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 in mines;

(c) promote a national preventive 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 preventive 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.

51. The competent authority should provide the tripartite committee with the necessary information required to perform its functions.

52. The powers and functions of the tripartite committee should be determined by agreement between the competent authority, employees and workers' representatives, or by national laws or regulations.

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

4.1. Introduction

53. Numerous other principles contained in existing ILO instruments, too lengthy to reproduce in this text, are relevant to OSH in opencast mining. These address: OSH management systems; reporting, recording and notification of work-related injuries and diseases, ill health and dangerous occurrences; and occupational health services.

4.2. OSH management systems

54. The process of improving working conditions in opencast mines should be approached systematically. With a view to achieving acceptable and 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 mine and appropriate to its size and the nature of its activities.

55. Typically, an OSH management system should comprise the following main elements:

(a) OSH policy;

(b) necessary conditions for the executing organization, that is, establishment of responsibility and accountability, competence and training, documentation, communication and information;

(c) worker participation;

(d) hazard identification, risk assessment and control, planning and implementation of OSH activities; and

(e) assessment and evaluation of OSH performance, including the collection of data, and developing actions for improvement.

56. Their design and application at national and mine levels should be guided by the *ILO Guidelines on occupational safety and health management systems, ILO–OSH 2001*.

4.3. Reporting, recording and notification of work-related injuries and diseases, ill health and dangerous occurrences

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

58. Similarly, in the establishment, review and application of systems for the reporting, recording and notification of work-related injuries and diseases, ill health and dangerous occurrences, 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), the ILO List of Occupational Diseases (revised 2010), and the ILO code of practice *Recording and notification*

of occupational accidents and diseases (1996). The competent authority should establish a nationally consistent approach to collecting and reporting statistics on occupational accidents, injuries and diseases.

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

(a) provide reliable information about occupational accidents, dangerous occurrences and occupational diseases at mine and national levels;

(b) identify major safety and health problems arising from opencast mining 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

60. 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.

5. Hazard identification, risk assessment and control

5.1. General principles

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

(a) eliminate the hazard;

(b) control the risk at source, such as substitution (for example, replacing hazardous equipment or substances with less hazardous equipment or substances) 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 PPE, having due regard to what is reasonable, practicable and feasible, and to good practice and the exercise of due diligence.

62. 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. Hazard identification

63. 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, dangerous occurrences and illness;

(d) the way work is organized, managed, carried out and any related changes;

(e) the design of workplaces, work processes, materials, plant and equipment;

(f) the fabrication, installation and commissioning and 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 responsibilities in relation to and of contractors; and

(i) the inspection, maintenance, testing, repair and replacement of plant and equipment.

5.3. Risk assessment

64. Risk assessment is 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 assessed level of risk. The priority for control increases as the assessed level of risk rises.

65. The risk-assessment process should take account of the likelihood and severity of injury or illness from the identified hazard. There are many established and recognized methods and techniques that can be implemented for the purpose of risk assessment.

5.4. Risk control

66. Unless a particular hazard or exposure to the hazard is removed, the risk associated with such a hazard can never be completely eliminated. In such cases such a risk should be controlled following the order of priority described in Section 2.3, paragraph 30.

67. 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.

5.5. Evaluation

68. The processes of hazard identification, risk assessment and control should be subject to a documented evaluation of effectiveness and modified as necessary, to establish an ongoing process for continual improvement.

69. Evaluations should take into consideration advances in technology, knowledge and experiences nationally and internationally.

70. Practical examples and guidance can be found in *A 5 STEP GUIDE for employers, workers and their representatives on conducting workplace risk assessments* (ILO, 2014) and Training Package on Workplace Risk Assessment and Management for Small and Medium-Sized Enterprises (ILO, 2013).

6. Management of change

6.1. Managing change

71. The impact on OSH of internal changes (for example, in staffing or due to new processes, working procedures, organizational structures or acquisitions) and external changes (for example, 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.

72. A workplace hazard identification and risk assessment should be carried out before any modification or introduction of new work methods, materials, processes or machinery.

6.2. Non-routine work

73. While much of what happens at a mine site should be covered by established controls developed through the risk-management process, there will always be situations that may not be adequately covered by those arrangements. This gives rise to a need to develop and implement processes to identify such "non-routine" work, or instances where established procedures are seen as inadequate.

74. Such non-routine work might include:

(a) a type of work that has never been performed before at the site;

(b) work that is only performed infrequently;

(c) work that is outside normal duties;

(d) work that does not have a documented procedure;

(e) work that must be performed in a different way to a documented procedure (including instances where a procedure is identified as inadequate); and

(f) "routine" tasks that carry a particular risk and warrant oversight before proceeding.

75. The key to managing the risks of such work is to halt the ongoing operation to allow for an established degree of assessment before proceeding. This provides an opportunity for situational awareness to be improved before proceeding.

76. Responses to the identification of non-routine work might include:

(a) discussion with a supervisor;

(b) performance of an "on the job" assessment to an established standard before proceeding;

(c) performance of a more formal job safety analysis to an established standard prior to the work proceeding;

(d) development or redevelopment of a documented procedure to cover the work;

(e) conduct of a formal risk assessment and development of appropriate controls; or

(f) implementation of an established permit-to-work system (this is commonly the case for work such as work at heights, or work in a confined space).

77. Arrangements to support this approach should be in place very early on in the development and operation of a mine site. It should be made clear, and accepted, that an unacceptable response to non-routine work is to "do nothing".

7. Life-cycle approach

78. In pursuing improvements in OSH, it is useful to consider the entire life cycle of a facility or mine. This is so for two reasons:

(a) risk management is generally most effective if applied early in the life cycle, as it allows for the adoption of generally more effective and less costly control measures, since less-effective retro-engineering is avoided; and

(b) the nature of risk changes throughout the life cycle, necessitating reassessment of those risks.

79. The main stages in an opencast mine's life cycle are the concept, the design, the development/acquisition, the commissioning/implementation, the operation, the maintenance/modification, the decommissioning and the disposal phases. Specific activities take place at each of the following stages and require specific attention.

Concept

80. Even at this early stage, decisions are made that can have a significant impact on the safety and health implications of a proposed facility. Examples are the choice of inherently more safe or healthy technologies, or the placement of a facility in relation to neighbouring communities.

Design

81. At this stage, safety engineering concepts should be applied such as the use of the hierarchy of controls and the use of backup or redundancy for critical controls. In addition, ergonomic principles should be applied to maximize the operability and maintainability of plant. The design phase also provides an

opportunity to ensure that a facility will be compatible with existing or other proposed facilities.

Development/acquisition

82. This typically comprises a building phase in which personnel may be exposed to a variety of hazards. This is especially of concern for on-site assembly where a mine operator may share the overall responsibility for safety and health. The acquisition of facilities also falls in this phase in which an important consideration is adequate specification of safety and health requirements and their communication to suppliers. Of particular concern at this phase is the acquisition of after-market, or second-hand, facilities. While this may be economically attractive, care should be taken that second-hand facilities meet safety and health requirements, to avoid "importing problems".

Commissioning/implementation

83. At this stage, adequate procedures for new facilities should be implemented along with training and the assessment of the competence of workers. Facilities should be systematically commissioned while monitoring for performance in design intent. In particular, the effective operation of critical controls should be evaluated at this stage.

Operation

84. During operation, information should be gathered about the safety and health performance of the facility. Employers should actively seek feedback from workers closely involved in operations. Data thus gathered should be used as input into maintenance planning, as well as input into future design, development and acquisition processes. The guidance in Sections 10.1.3 to 10.1.6 on the development of mine plans, their updating and the recording of all relevant changes is particularly important in this phase.

85. Parts of the mine that are no longer in operation should at this stage be closed or put into care and maintenance until decommissioned, if practicable.

Maintenance/modification

86. This phase involves both routine maintenance and modifications in the light of issues arising during operation. Routine maintenance should be risk-based and particular care should be taken to isolate or dissipate stored energy sources (for example, accumulators, hydraulic circuits, capacitive elements or springs with stored mechanical energy). Modification of facilities or equipment is a form of non-routine work and should be treated as such.

Decommissioning

87. This phase involves the transition of facilities to a benign state through processes such as disassembly, demolition, draining, filling and dissipation of hazardous energies.

Disposal

88. The remains of facilities should be disposed of responsibly and in accordance with national laws and accepted standards. Particular attention should be paid to the disposal of such items as radioactive material, chemicals (including PCBs) and asbestos-containing materials.

8. Emergency response plan

8.1. General emergency provisions

89. An emergency response plan, specific to an opencast mine, should be established by the employer in charge of the mine, in cooperation with workers, external emergency services and other relevant bodies, for reasonably foreseeable industrial incidents and natural disasters. Risk assessment may be an appropriate means to identify relevant potential industrial incidents and natural disasters.

90. The emergency response plan should incorporate the fire and emergency procedures, the first-aid and medical services, and the emergency plan (under Section 10.1) suggested by this code. Where an opencast mine has one or more tailings dams, the emergency response plan for the mine should be extended to incorporate relevant provisions (see in particular Section 9.9.3.6).

91. In developing an emergency response plan, the following might be considered:

(a) establishing an emergency response team or brigade;

(b) the chain of command along with appropriate backups and control structures, including roles and responsibilities, in the case of an emergency;

(c) the establishment of a command and communication centre (which may be separate from normal work areas), where a full working copy of the emergency response plan is available, including emergency contact details;

(d) the triggers for declaring an emergency (emergencies may be of different classes depending on their severity);

(e) who should initiate an emergency response and by what means;

(f) escape procedures and escape routes, including signings and markings indicating escape routes to be used;

(g) means to account for all persons after evacuation;

(h) procedures for the shutdown of the critical facility when necessary;

(i) means of ensuring that external emergency services are notified when necessary;

(j) means of ensuring that competent authorities are notified as required;

(k) rescue and medical roles for those who will perform them;

(l) the implementation of site security arrangements (including management of media and bystanders);

(m) the protection of vital records, in whatever form (for example, secure off-site backup or fireproof storage);

(n) the training and appropriate retraining of all workers at an opencast mine and any person who may be involved in an emergency; and

(o) any other provisions relevant to the site.

92. Where external emergency services (for example, mine rescue, fire and ambulance services) form part of the emergency response plan, the provisions and infrastructure of the plan should, as far as practicable, be compatible with those services. External emergency services should be made familiar with relevant parts of the opencast mine's emergency response plan.

93. Small mines should consider arrangements with other mines and external emergency service providers to ensure an adequate emergency response.

94. Regular testing of the emergency response plan should be undertaken (for example, by conducting exercises) and workers' representatives should be involved in exercise planning, conduct and debriefing.

95. A competent authority should monitor the development and implementation of emergency response plans at opencast mines within their jurisdiction.

96. Where more than one competent authority is involved, they should liaise and make a coordinated response when informed of an emergency at an opencast mine.

8.2. Fire protection and firefighting

8.2.1. General provisions

97. Efficient means of fire protection and firefighting should be available at all times in all buildings and at all points in or about an opencast mine where a fire hazard has been identified.

98. The means of fire protection and firefighting should be in conformity with national laws and accepted standards.

99. The employer in charge of the mine should assign a competent and experienced person to:

(a) prepare a fire precaution plan showing all locations in the mine where a fire hazard exists, the nature of the hazard, and the location and type of firefighting equipment provided;

(b) make a regular check of all the strategic points in or about the mine and of the firefighting equipment and keep a durable record of these checks; and

(c) make the records of fire equipment checks available to workers' representatives.

8.2.2. Precautions against fire

100. All storage tanks and piping containing flammable or combustible liquids should be:

(a) so designed and constructed as to be capable of resisting the working pressures and stresses, and made of suitable material for any projected contents;

(b) marked to warn all persons that these contain flammable or combustible liquids;

(c) maintained such that leakage is prevented; and

(d) isolated or separated from ignition sources and combustible material.

101. All storage tanks containing flammable or combustible liquids should be:

(a) vented or otherwise constructed to prevent development of pressure or vacuum as a result of filling, emptying or atmospheric temperature changes; and

(b) contained within structures capable of holding in excess (for example, 110 per cent) of the contents of the largest tank.

8.2.3. Provision of fire protection

102. Based on a risk assessment, fire protection equipment (for example, fire extinguishers) should be specifically provided, inspected, maintained and tested in accordance with manufacturers' recommendations and regulations:

(a) where combustible and flammable material is stored;

(b) at haulage terminals or vehicle stops;

(c) at engine rooms, boiler houses, locomotive or vehicle garages, workshops, kitchen facilities, living quarters, offices or warehouses;

(d) on vehicles;

(e) at refuelling points for vehicles;

(f) in electrical switch rooms and at distribution points; and

(g) in any other place in an opencast mine where a fire hazard exists as determined by the risk assessment.

103. Flammable liquids, which are not in storage tanks, should be stored in purpose-designed flammable liquid storage cabinets.

104. Covered metal containers or their equivalent should be provided wherever waste combustible materials, including liquids, may temporarily accumulate.

105. These containers should be emptied regularly and their contents disposed of in a safe and responsible manner.

8.2.4. Firefighting and rescue

106. Firefighting and rescue procedures should be established together with a fire alarm system to give a prompt warning to persons who may be endangered by a fire.

107. The employer in charge of the mine should provide for the establishment of a team or teams of trained persons, compatible with the size of the mine and the number of persons employed, to be deployed in case of fire.

108. Mobile or portable firefighting equipment and, where appropriate, fire hydrants, should be kept available and maintained at an easily accessible location for use at any time.

109. Where an external firefighting organization may be relied upon, uniform fittings or readily available adaptors should be provided for all hydrants.

110. Provisions should be made to ensure all relevant information, including mine rescue plans, is provided in a readily accessible place to external emergency services.

111. Suitable rescue equipment, including self-contained breathing apparatus, should be kept easily available; persons who may need to use it should be properly instructed and regularly trained in its use.

8.3. First aid and emergency medical services

8.3.1. First-aid requirements

112. First-aid equipment and facilities should as a minimum meet the requirements of national laws and accepted standards.

113. The following arrangements for first aid and emergency treatment in case of accident should be provided at any opencast mine:

(a) suitable, regularly replenished and properly maintained first-aid kits should be maintained at the mine for use in case of accident;

(b) sufficient first-aid attendants should be on duty at all times when the mine is in operation and their contact details should be easily available;

(c) appropriate, sterile dressings and disinfectant should be made available at all points where mining operations are performed; and

(d) a conveniently sited and suitably accessible first-aid room which permits the transfer of patients by stretcher should be set aside for the sole use of first aid, medical examination and ambulance work. This room should be maintained to a suitable level of hygiene and condition.

114. Unless there is a hospital or other suitable medical facility nearby and conveniently accessible to the mine and a suitable ambulance properly maintained and available at all times during working hours, a convenient location should be provided, furnished with a sufficient number of beds, together

with the necessary equipment and supplies, for the preliminary treatment of injuries or illness and suitable for the temporary use of persons injured at the mine.

115. A first-aid register should be kept at the mine for recording the names of persons to whom first aid has been rendered and particulars of injuries and treatment. The register should only be accessible to authorized persons. The register may be made available, excluding confidential information, to a competent authority and the safety and health committee for the purposes of incident and injury analysis.

8.3.2. First-aid training

116. Based on a risk assessment and in compliance with national laws, there should be a suitable number of first-aid attendants holding recognized and valid first-aid certificates in every mine. First-aid training should be made available to all workers.

9. Specific hazards

9.1. Hazardous substances and atmospheres

117. As far as practicable workers should not be exposed to airborne contaminants, harmful physical and chemical agents or other hazards present in the working environment. A suitable system should be established to determine the quality of the air and identify any physical or chemical agent likely to be hazardous in the atmosphere in the vicinity of the mining operation, and of all locations in or about the mine where workers may be called upon to work or travel.

118. National laws should specify and regularly review exposure limits for all airborne contaminants, harmful physical and chemical agents, and other hazards which may be encountered in the working environment. Provisions should be made to ensure that:

(a) the safe working methods and, as far as is reasonably practicable, the safest physical and chemical agents are chosen and used;

(b) special procedures, approved by the competent authority, are enforced wherever workers may be exposed to ionizing radiation hazards from any source; and

(c) the exposure limits specified by national laws are not exceeded.

119. Where it is necessary in order to minimize the risk to workers, written instructions should be prepared specifying the correct procedure to be observed in these circumstances. The necessary steps should also be taken to inform all workers of the possible hazards and the precautions to be taken when

hazardous substances are likely to be encountered at the mine, including evacuation procedures.

9.1.1. Chemicals in the workplace

9.1.1.1. Hazard description

120. A chemical substance is an element, compound or mixture which may be present in the workplace in the form of a liquid, solid (including particles) or gas (vapour, aerosol). These substances may present a hazard as the result of contact with the body or absorption into the body. Absorption can occur through the skin, by ingestion or by inhalation. Chemical substances can also present a fire or explosive hazard in the workplace.

121. Chemicals can have acute (short-term) and/or chronic (long-term) health effects with or without any latency period. They may present a safety hazard as a result of their chemical and physical properties.

9.1.1.2. Assessment of risk

122. Workers may be exposed to chemicals actively during their use in production processes, as well as to chemicals generated by a process or used in maintenance activities. Exposure may occur passively due to the presence of chemicals in the workplace environment. The advice of the competent authority should be sought regarding exposure limits and other standards to be applied.

123. Safety data sheets (SDS) 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 Rev.6) (United

Nations, 2015) provides guidance on the preparation of labels, SDS and the provision of information to workers.

124. The production of SDS in electronic format should be encouraged. Chemical safety data sheets 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.

125. 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 SDS, and date of issue.

126. 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.

9.1.1.3. Control strategies

9.1.1.3.1. Training and information

127. 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 other on-site employers whose workers could be exposed about chemical hazards and appropriate protective measures;

(e) ensure that 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.

128. 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 workers could be affected.

129. The hazard communication programme should include the following:

(a) how this part is put into practice at the mine through the use of:

(i) hazard determination;

(ii) all forms of signals, signs, labels and other forms of warning;

(iii) SDS; and

(iv) worker training.

(b) a list or other records identifying all hazardous chemicals known to be at the mine, which should:

(i) use a chemical identity that permits cross referencing between the list, a chemical's label and its SDS; and

(ii) be compiled for the whole mine or by individual work areas.

(c) at mines with more than one employer, the methods for:

(i) providing other employers with access to SDS; and

(ii) informing other employers about:

(1) hazardous chemicals to which their workers could be exposed;

(2) the labelling system on the containers of these chemicals; and

(3) appropriate protective measures.

130. 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 SDS for each hazardous chemical used at the mine which lists the chemical's hazards and protective measures.

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

9.1.1.3.2. Hazard control

132. 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 (for example, 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;

(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 (if reusable) or their disposal; and

(f) the provision of appropriate hygienic conditions and facilities (for washing) in places where food or tobacco are consumed.

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

9.1.2. Inhalable and respirable substances

9.1.2.1. Hazard description

134. The pulmonary system (lungs) can be affected by exposure to harmful agents through acute (short-term) injury to lung tissue, the development of pneumoconiosis, including silicosis, and pulmonary dysfunction. Some airborne contaminants can lead to the development of cancers. 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. In addition, high levels of dust, as often found at loading and tipping points,

material transfer points, crushing stations and haulage roadways, can impair workers' visibility.

9.1.2.2. Assessment of risk

135. The assessment of risk should begin with a review of production and maintenance processes in order to understand the content, form and volume of inhalable substances associated with opencast mining. This should include information acquired from suppliers for materials brought on-site through the use of SDS.

136. 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 other relevant standards, such as an exposure assessment protocol issued by the competent authority.

137. Exposure assessments should be conducted by competent persons. The assessment should include a programme for the measurement of airborne contaminants to:

(a) determine the extent of exposure of workers; and/or

(b) check the effectiveness of engineering control measures.

138. Account should be taken of specific work situations in which workers are likely to be exposed, for example, to:

(a) hazardous fumes as by-products (for example, welding);

(b) hazardous substances and/or oxygen deficiency in confined spaces;

(c) prolonged periods (such as during overtime) with the risk of accumulation of higher doses;

(d) higher concentrations due to fluctuations in ambient conditions (for example, hot environments where vapour pressures of hazardous substances may be elevated);

(e) absorption through multiple routes (inhalation, ingestion, absorption through the skin); and

(f) hazardous substances that may be present even in concentrations below exposure limits while performing arduous tasks.

139. Employers should provide information to workers and their representatives regarding the risk assessment process, and the results of risk assessments. Expert advice should regularly be sought about exposure limits relating to inhalable agents.

9.1.2.3. Control strategies

9.1.2.3.1. Dusts

140. Suitable arrangements should be made to control inhalable and respirable dusts at all working places. This is especially important where dust may be created, such as loading and tipping points, material transfer points, crushing stations and haulage roadways.

141. In implementing precautions against airborne dust, the most effective method is to control emissions at source. This usually requires fit-for-purpose equipment, processes and handling methods. Special attention should be paid to the following circumstances, operations or locations:

(a) the immediate period following blasting operations;

(b) the operation of drilling rigs or other rock drills which are not fitted with effective dust collection or suppression devices;

(c) loading or unloading points, particularly under dry conditions;

(d) all mine haulage roadways;

(e) all crushing, screening and treatment plants, particularly at conveyor belt transfer points;

(f) stone-cutting and polishing operations; and

(g) worked-out areas, dumps and similar sites where windblown dust may become excessive.

142. Based on hazard identification, exposure assessment and monitoring, provision should be made for mechanical ventilation to be supplied and used in all stagnant zones, dead-end tunnels and other poorly ventilated places.

143. Methods such as dust suppression using water and/or surfactants, extraction or filtering should be implemented where practicable.

144. Where the above measures do not suffice, employers should:

(a) provide suitable PPE until such time as the risk is eliminated or minimized to an acceptable level that would not pose a threat to health;

(b) prohibit eating, chewing, drinking and smoking in contaminated areas;

(c) provide adequate facilities for washing and changing and for storage of clothing (with everyday clothing separated from work clothing), including arrangements for laundering or disposing of contaminated clothing;

(d) use signs, labels and other warnings; and

(e) make adequate arrangements in the event of an emergency.

145. The competent authority should specify standards of dust concentrations and sampling methods for opencast mines.

9.1.2.3.2. Other inhalable substances

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

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

147. Training should specify special precautions to be taken for workers who perform work in confined spaces that might contain harmful inhalable agents. See Section 9.17 for additional information on safe work practices involving confined spaces.

148. Engineering controls should be developed and implemented 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.

149. 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, including PPE where absolutely necessary. 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.

150. The harmful effects of many inhalable agents may be made worse when inhalation occurs simultaneously with smoking. Areas that are separate from inhalable agents should be designated for smoking where appropriate. Accumulation should be avoided of toxic metal dusts or fumes on surfaces where they may be deposited. Surface contamination may lead to secondary exposure through ingestion.

151. Where applicable the provisions in the Asbestos Convention (No. 162), and Recommendation (No. 172), 1986;

ILO codes of practice *Occupational exposure to airborne substances harmful to health* (Geneva, 1980) and *Safety in the use of asbestos* (Geneva, 1984); and *Dust control in the working environment (silicosis)*, ILO Occupational Safety and Health Series No. 36 (Geneva, 1977) should be considered.

9.1.3. Radiation

9.1.3.1. Hazard description

152. All human beings are exposed to a background of naturally occurring radiation which is relatively harmless. However, when sources of radiation are concentrated or there is increased exposure, harmful effects may result. The most common harmful effect, at relatively low doses, is a change to chemical compounds in the body which can lead to diseases such as cancer. This is reason alone to minimize exposure to harmful radiation to accepted safe exposure levels.

153. Radiation can be classified in a number of ways. For example, the sun's radiation consists of electromagnetic waves (light, ultraviolet (UV) and infrared) while decaying uranium produces alpha and beta particles and gamma rays.

154. The penetrative power of such radiation varies: alpha particles have very little penetrative power and can be stopped by a sheet of paper; beta particles have more penetration and can be stopped by cardboard; while gamma rays are very penetrative and require a lead shield to stop them.

155. Radiation can also be classified by the amount of energy it has. For example, gamma rays contain a high level of energy, while infrared radiation contains relatively little energy. Radiation with enough energy to cause a change in atoms that it hits is called ionizing radiation. Radiation without that amount of energy is called non-ionizing radiation.

156. Higher energy ionizing radiation can affect atoms in cells of the body leading to potentially permanent damage. Examples are: the effect of higher energy UV light on unprotected skin through excessive sun exposure possibly leading to skin cancers; or the inhalation of radioactive dust leading to exposure to alpha radiation and possible lung cancer.

157. Ionizing radiation may affect the body via three routes:

(a) radiation directly on the skin;

(b) inhalation (for example, of radioactive dust); or

(c) ingestion (as a result of poor hygiene practice).

158. Non-ionizing radiation can only impact the body via irradiation. Alpha particles cannot penetrate the dead outer layer of the skin, but they make a dense ionization trail along their stopping track, so they can produce damage to biological tissue if emitted inside the body following ingestion or inhalation. Beta particles carry less energy, and give it up in a much more spread out and less dense manner than alpha particles, causing less damage. Gamma rays are very penetrative and can affect the entire body through external irradiation.

159. Absorption in the UV and visible portions of the spectrum can produce photochemical reactions. In the case of infrared radiation, all of the absorbed radiant energy is converted into heat. Exposure to some radio-frequency and microwave radiation (also forms of electromagnetic radiation) can result in the formation of cataracts of the eye.

160. Exposure of the eyes to visible and infrared radiation can cause thermal injury to the retina and damage to the lens, which may result in the formation of cataracts. Exposure of the eyes to UV radiation can result in inflammation of the conjunctiva and cornea.

9.1.3.2. Ionizing radiation

9.1.3.2.1. Assessment of risk

161. Likely sources of ionizing radiation at opencast mines are the minerals or material mined, or equipment which uses a form of radiation to perform its function. Examples of the former are:

(a) uranium mining, on-site transportation and processing; and

(b) mineral sands and rare earths (such as rutile, zircon, leucoxene).

162. Equipment which may be a source of radiation, unless correctly used and maintained, includes:

(a) devices using sealed radio-active sources, for example:

(i) density gauges;

(ii) level gauges;

(iii) multiphase flow metres;

(iv) smoke detectors;

(v) borehole logging;

(vi) moisture gauges; or

(vii) non-destructive testing equipment (gamma rays); and

(b) irradiating devices (X-rays), for example:

(i) XRF analytical equipment (handheld or in on-site laboratories); and

(ii) non-destructive testing equipment.

163. The presence and form of these sources and the degree of likely exposure of workers forms the basis for the risk assessment of the hazard of ionizing radiation.

164. Radon gas, while a source of concern in underground mines, is unlikely to be encountered in opencast mines except in unventilated areas containing radioactive material. Such areas should be adequately ventilated before any entry by workers.

9.1.3.2.2. Control strategies

165. The competent authority should be consulted about national laws and accepted standards covering radiation exposure.

166. Control of potential radiation exposure should begin with a comprehensive survey of possible radiation sources, which should be conducted by an industrial hygienist with experience in radiation protection or other competent and authorized persons. Based on the survey information, a radiation protection programme (RPP) should be developed, as part of the OSH management system, and implemented with the advice of an industrial hygienist and qualified industrial safety specialist or other competent and authorized persons. A radiation protection officer should oversee the operation of the RPP. The RPP should make provision for:

(a) monitoring and dose assessment, including:
    (i) initial surveys of gamma radiation, airborne radioactive dust and surface contamination levels;
    (ii) monitoring during stagnant atmospheric conditions when radiation exposure may increase;
    (iii) ongoing measurement and recording of gamma ray dose rates, with particular attention to fixed working locations;
    (iv) ongoing measurement of radioactive dust concentrations;
    (v) ongoing measurement of surface contamination, with particular emphasis on mining, crushing and processing areas; and

(vi) assessment and recording of occupational exposures including both individual and workplace monitoring;

(b) engineering measures, including:

(i) a preference for employing design, installation, maintenance, operational and administrative arrangements and instruction of workers as far as possible in the use of PPE;

(ii) the use of effective ventilation and dust capture;

(iii) minimization of dust generation by appropriate blasting patterns and timing, and the use of water and other means of suppressing dust;

(iv) the use of enclosed operator cabs on mining equipment to minimize dust exposure;

(v) design and operation of crushing and screening plants to keep the release of contaminants as low as possible, and to facilitate the removal of accumulated contaminated material;

(vi) special care during maintenance activities to prevent exposure to accumulated radioactive material in pipes and vessels; and

(vii) where practicable, the handling of concentrated radioactive material with automated equipment.

(c) administrative protective measures, including:

(i) the maintenance of good housekeeping and cleanliness;

(ii) prompt clean-up of spills (while providing area monitoring and suitable PPE);

(iii) cleaning of plant or materials leaving the mine site (for example, wash down facilities for vehicles); and

(iv) supplementary use of PPE, including:

(1) coveralls, head coverings, gloves, boiler suits and impermeable footwear and aprons commensurate with the risk of contamination and working conditions;

(2) facilities to allow the deposition of used PPE and contaminated clothing prior to showering and changing into clean clothes; and

(v) provision of suitable disposal, decontamination or laundry facilities for contaminated clothing or items;

(d) personal hygiene measures, including:

(i) provision of hand and face washing facilities which are used before rest or meal breaks and at the end of a shift;

(ii) provision of clean eating areas, supplied with potable water and good quality air;

(iii) prohibition of eating, drinking, chewing (gum or tobacco), smoking or taking snuff in areas where radioactive material could be ingested;

(iv) first-aid procedures, which should include special precautions for cleaning of wounds; and

(v) as a last resort, job rotation without penalty (for example no loss of pay) may be considered as a means of reducing the exposure of workers.

167. Health surveillance measures for an opencast mine should take into account the potential of exposure to ionizing radiation where this is an issue at the mine. Workers should be instructed about radiation types, their potential effects and how they are monitored and measured.

168. Further information: *Occupational radiation protection in the mining and processing of raw materials: Safety guide* (International Atomic Energy Agency and ILO), Vienna, 2009; *International basic safety standards for protection against ionizing radiation and for the safety of radiation sources* (FAO, IAEA, ILO, OECD/NEA, PAHO and WHO), Vienna, 1997, and the ILO code of practice *Radiation protection of workers (ionizing radiations)* (Geneva, 1987).

9.1.3.3. Non-ionizing radiation

9.1.3.3.1. Assessment of risk

169. There should be an assessment of equipment and activities likely to give rise to hazardous exposure to non-ionizing radiation. The assessment might include such matters as:

(a) potential exposure to sunlight (UV, infrared and visible radiation);

(b) the altitude at which outside work is to be performed (the effect of the sun's rays is stronger at higher altitudes);

(c) the use of lasers at the mine site (a laser beam consists of strong, coherent, visible radiation); and

(d) the use of other potential UV sources, such as fluorescent and discharge type light sources, electric arc welding and plasma torches.

9.1.3.3.2. Control strategies

170. The competent authority should be consulted about national laws and accepted standards covering radiation exposure.

171. Control of potential radiation exposure should begin with a comprehensive survey of possible radiation sources, which should be conducted by an industrial hygienist with experience in radiation protection or other competent and

authorized persons. Based on the survey information, a radiation protection programme (RPP) should be developed, as part of the OSH management system, and implemented with the advice of an industrial hygienist and qualified industrial safety specialist or other competent and authorized persons. A radiation protection officer should oversee the operation of the RPP.

172. It is desirable to limit sun exposure by wearing appropriate clothing (including sunglasses), limiting periods of exposure by the provision of shade and the use of protective sun screen on exposed skin. As indicated above, these measures may be more critical at higher altitudes.

173. Guidance on the use of lasers may be found in *The use of lasers in the workplace: A practical guide*, ILO Occupational Safety and Health Series No. 68 (Geneva, 1993).

174. Excessive exposure to non-solar UV radiation may be reduced by:

(a) ensuring that tungsten-halogen lamps are only used with glass filters; and

(b) ensuring that electric arc welding is only done while wearing appropriate PPE (on both the welder and any observers).

175. Health surveillance measures for an opencast mine should take into account the potential for exposure to non-ionizing radiation where this is an issue at the mine. Workers should be instructed about radiation types, their potential effects, and how they are monitored and measured.

9.2. Electric and magnetic fields

176. Electric and magnetic fields are found around all equipment that passes an electric current. Some studies have shown that exposure to magnetic fields can cause certain types

of cancers and brain tumours. They can also affect a person's mood, alertness, heart function, and the immune and reproductive systems. Some individuals suffer from skin irritation in the presence of electrical fields.

177. Workers with heart pacemakers should not be employed in areas where they may be exposed to magnetic fields of a strength likely to affect the device. Equipment producing such fields should be clearly signposted.

178. Unlike electric fields, magnetic fields cannot be easily screened off, as they can pass through all materials. However, the power of the field rapidly diminishes as the distance from the source of the magnetic field increases. It is generally advisable to shut down all electrical equipment when not in use.

179. Fixed installations which generate high-strength fields, such as transformers and switching stations, should be sited as far away from work areas as possible.

180. Further guidelines and recommendations can be found in *Protection of workers from power frequency electric and magnetic fields: A practical guide*, ILO Occupational Safety and Health Series No. 69 (Geneva, 1994).

9.3. Stored energy

9.3.1. Hazard description

181. The opencast mining industry uses a variety of machinery which contains stored energy, for example, pressure energy in pneumatic and hydraulic systems, electrical energy in capacitive elements or batteries, or mechanical energy in components under strain. The unexpected release of these energies can lead to very serious injury to workers in the vicinity. Of particular concern are maintenance activities which typically involve workers being in close proximity to machinery with stored energy (unless isolated

or dissipated) and undertaking activities which are likely to compromise the containment of that energy.

182. A particular hazard is presented by hydraulic and other gas or steam systems which typically operate under very high pressures. Workers in close proximity to these systems may suffer hydraulic fluid injection injuries which, in addition to the physical damage caused, can result in necrosis of surrounding tissue due to the common components of hydraulic fluids.

9.3.2. Assessment of risk

183. An initial and ongoing risk assessment should be conducted to identify machinery and its components containing stored energy which, if accidently released, can result in injury to workers.

9.3.3. Control strategies

184. Workers who may work in close proximity to machinery containing stored energy should be identified and made aware of the potential hazards of the unexpected release of that energy. This especially applies to workers involved in maintenance activities.

185. Where there are specific hazards, such as electricity, pressure differentials, poor air quality or radiation, these should be identified and controlled so that workers and others in the workplace are not endangered. This should include confirmation that:

(a) electrical, gas and liquid connections have been isolated and any excess pressure in the systems concerned has been discharged;

(b) suitable guarding or enclosure of equipment or components that can unexpectedly release energy;

(c) any unexpected movement of machinery is prevented;

(d) suspended loads have been secured;

(e) scaffolding, work platforms and ladders used for the work have an adequate stability and carrying capacity;

(f) the tools to be used are in good condition and suitable for their intended purpose;

(g) when tanks or confined spaces are serviced, inspected or cleaned, measures have been taken to control the danger from lack of oxygen, toxic gasses or other hazardous substances, and that appropriate emergency procedures are in place;

(h) access to the danger area is restricted to essential personnel;

(i) appropriate PPE and protective clothing are supplied and used; and

(j) equipment or components that contain or store energy, including pressure vessels, actuators and pipes, should be maintained and inspected in accordance with manufacturers' recommendations and relevant laws.

186. To isolate or dissipate potentially damaging energy sources, the following action should be taken:

(a) machinery should be fitted with a means to disconnect and isolate it from all energy sources. Such isolators should be clearly identified. They should be capable of being locked in the "off" position if reconnection could endanger workers. This is especially important where a worker is unable to check that the energy is still cut off due to the inaccessibility of the area;

(b) identify and implement specific procedures for the control of hazardous energy. These procedures should include preparation for shut-down, lock-out or tag-out, a permit-to-work system and verification of isolation, as part of a formal risk management system;

(c) after the energy is cut off it should be possible to dissipate normally any energy remaining or stored in the circuits of the machinery without risk to workers;

(d) certain circuits may remain connected to their energy sources in order, for example, to hold parts, to protect information, and to light interiors. In this case, special steps should be taken to ensure worker safety;

(e) where there is a potential for fluid release, the pipeline should be blanked off; and

(f) steps to safely re-energize and reinstate equipment to operational status.

9.4. Noise

9.4.1. Hazard description

187. 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. In opencast mines, workers are exposed to noise from many types of machinery, equipment and processes.

9.4.2. Assessment of risk

188. The competent authority should set standards for the maximum noise dose considered acceptable to prevent hearing impairment in the working environment on a daily basis and for the maximum peak noise level.

189. The assessment of risk should, as appropriate, consider the:

(a) risk of hearing impairment;

(b) degree of interference to communication essential for safety purposes; and

(c) risk of fatigue, with due consideration of the mental and physical workload and other non-auditory hazards or effects.

190. 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 to noise;

(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.

191. Noise measurements should be used to:

(a) quantify the level and duration of the exposure of workers and compare it with exposure limits, as established by the competent authority or internationally recognized standards;

(b) identify and characterize the sources of noise and exposed workers;

(c) create a noise map for the determination of risk areas;

(d) assess the need both for engineering noise prevention and control and for other appropriate measures and their effective implementation; and

(e) evaluate the effectiveness of existing noise prevention and control measures.

9.4.3. Control strategies

192. 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 worker's noise exposure exceeds the permissible level, the employer should use all feasible engineering and administrative controls to reduce the worker's noise exposure to the permissible exposure level, and enrol the worker 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) continue to examine methods and controls to lower the noise levels causing the overexposure.

193. In the case of new processes and equipment, as far as practicable:

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

(b) the workplace layout should be arranged to minimize noise exposure to the workers.

194. In the case of existing processes and equipment, it should first be considered 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, replacing its noisy parts with quieter alternatives should be considered.

195. 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.

196. 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 perspective, 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.

197. If enclosure of the noise source is impracticable, consideration should be given to alternative sound transmission-path treatment using a barrier to block or shield the worker from the noise hazard. Barriers should be designed and manufactured in accordance with the requirements and needs indicated by the user, consistent with accepted standards.

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

(a) install an acoustical booth or shelter for those job activities where the movement of the worker is confined to a relatively small area;

(b) minimize, by appropriate organizational measures such as job rotation, the time workers spend in the noisy environment;

(c) designate specific areas with high noise levels and install appropriate warning signs indicating that hearing protection is mandatory;

(d) provide hearing protection; and

(e) offer audiometric testing.

199. Workers who may be, or have been, exposed to noise levels exceeding occupational standards should receive initial and further regular audiometric testing (for example, within three months of commencing work, and at least annually). Workers who may be exposed to significant levels of noise should be 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.

200. Workers in noisy environments should be informed of the:

(a) results of their audiometric tests;

(b) factors leading to noise-induced hearing loss and the consequences, in non-auditory effects and social consequences;

(c) the precautions necessary, especially those requiring the intervention of workers or the use of hearing protection devices;

(d) effects that a noisy environment may have on their general safety; and

(e) symptoms of adverse effects of exposure to high levels of noise.

201. For further information refer to Chapter 9 of the ILO code of practice *Ambient factors in the workplace* (Geneva, 2001).

9.5. Vibration

9.5.1. Hazard description

202. Exposure of workers to hazardous vibration mainly comprises:

(a) whole-body vibration, when the body is supported on a surface that is vibrating, such as in vehicles 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.

203. Exposure limits should be established according to current international knowledge and data. Further detailed information can be found in Appendix III.

9.5.2. Assessment of risk

204. If workers are frequently exposed to hand-transmitted or whole-body vibration, and obvious steps do not eliminate the exposure, the employer should assess the hazard and risk to safety and health resulting from the conditions, and:

(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, machinery and equipment about their vibration emissions; or

(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.

205. Vibration measurements should be used to:

(a) quantify the level and duration of exposure of workers, and compare it with exposure limits as established by the competent authority or other standards to be applied;

(b) identify and characterize the sources of vibration and the exposed workers;

(c) assess the need both for engineering vibration control and for other appropriate measures, and for their effective implementation;

(d) evaluate the effectiveness of particular vibration-prevention and vibration-control measures; and

(e) if possible, determine the resonance frequencies.

206. 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.

207. 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.

9.5.3. Control strategies

208. 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.

209. 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 into equipment that causes vibration hazards; and

(f) use, where practicable, anti-vibration handles.

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

211. 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.

212. 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. Consideration should be given to jolt and jar effects in certain types of mobile equipment, for example bulldozers, while ripping hard, rocky earth.

213. 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.

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

215. Where the exposure might lead to injury if workers continue to 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.

9.6. Heat and cold stress

9.6.1. Hazard description

216. Risks arise in special conditions including when:

(a) temperature and/or humidity are 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 a low temperature; or

(f) work with bare hands is carried out for extended periods of time at low temperatures.

9.6.2. Assessment of risk

217. If workers are exposed in all or some of their tasks to any conditions listed above, 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.

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

219. The assessment of 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;

(b) a hot environment that makes respiratory protectors uncomfortable and less likely to be used, and necessitates restructuring of jobs in order to reduce the risks, for example by:

(i) minimizing exposure to 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.

220. 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 the 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.

9.6.3. Control strategies

221. When the assessment reveals that 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.

222. 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. If no other controls can mitigate the risk, PPE such as cooling jackets should be provided.

223. 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.

224. 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, preferably in an air-conditioned or cool resting room. The rest periods should be as prescribed by

the competent authority and should be 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.

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

226. 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.

227. 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 a strong wind, as the wind chill factor can result in exposed flesh cooling very rapidly.

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

229. 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 extremities.

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

(a) to recognize symptoms which may lead to heat stress or hypothermia, in themselves or others, and the steps to be taken to prevent onset and/or emergencies;

(b) in the use of rescue and first-aid measures; and

(c) in action to be taken in the event of the increased risk of accidents because of high or low temperatures.

231. 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.

9.7. Fatigue

9.7.1. Hazard description

232. Fatigue can be defined as a state of impairment that can include physical and/or mental elements, associated with lower alertness and reduced performance. Signs of fatigue include tiredness even after sleep, psychological disturbances, loss of energy and inability to concentrate. Causal factors include:

(a) physical/mental demands of work;

(b) shift work, especially night work;

(c) extended shifts (more than eight hours);

(d) excessive time spent commuting;

(e) work environment conditions; and

(f) individual factors, for example, a medical condition, illness, disease or personal factors, among other things, stress and anxiety.

233. Fatigue can be a contributing factor to dangerous occurrences or serious accidents because workers may not be alert or able to quickly respond to changing circumstances. In addition, prolonged fatigue can lead to long-term health problems.

234. Fatigue results from a number of factors, including environmental conditions, such as excessive heat, cold or noise; physical or mental overexertion; and/or insufficient rest and

sleep between activities (for example, from poor quality sleep). The inter-related causes of fatigue include:

(a) time of day that work takes place;

(b) length of time spent at work and in work-related duties;

(c) type and duration of work tasks and the environment in which they are performed;

(d) the ergonomic design of workstations and the environment in which work is performed;

(e) quantity and quality of rest obtained prior to and after a work period;

(f) activities outside work, such as family commitments or a second job; and

(g) individual factors, such as sleep disorders.

235. Acute fatigue is caused by immediate episodes of sleep deprivation; for example, because of long periods of wakefulness from excessively long shifts or night shifts without adequate daytime rest. Ongoing sleep disruption can lead to sleep debt and chronic sleep deprivation, placing individuals in a state of increased risk to themselves and to others. It results in:

(a) unpleasant muscular weariness;

(b) tiredness in everyday activities; and

(c) reduced coordination and alertness.

If sleep deprivation continues, work performance can deteriorate even further.

236. Fatigue can result from features of the work and the workplace and from features of a worker's life outside work. Levels of work-related fatigue are similar for different individuals performing the same tasks.

9.7.2. Assessment of risk

237. Work-related fatigue can and should be assessed and managed at an organizational level. The contribution of non-work-related factors varies considerably between individuals. Non-work-related fatigue is best managed at an individual level.

238. Work-related causes of fatigue include:

(a) aspects of the tasks being undertaken (for example, greater workload within standard shifts);

(b) roster design (for example, too many consecutive night shifts);

(c) unplanned work, overtime, emergencies, breakdowns and call-outs;

(d) features of the working environment (such as noise or temperature extremes); and

(e) commuting times.

239. Non-work-related causes of fatigue include:

(a) sleep disruption due to ill family members;

(b) strenuous activities outside work, such as a second job;

(c) sleep disorders;

(d) inappropriate use of alcohol, prescription and illegal drugs; and

(e) stress associated with financial difficulties or domestic responsibilities.

9.7.3. Control strategies

240. A fatigue risk assessment should be carried out and a written fatigue management programme drawn up for all operations and in accordance with national laws if national laws

prescribe. The fatigue management programme should specify working time arrangements where workers:

(a) carry out work between 7 p.m. and 6 a.m.;

(b) work more than 48 hours in any consecutive five-day period (working on each day) including unplanned work, emergencies, overtime, breakdowns and callouts; or

(c) do not have a minimum of two consecutive days off in any seven-day period.

Additional fatigue hazards identified during the risk assessment should be included in the plan.

241. The risk assessment and the fatigue management plan should be developed in consultation with workers and their representatives, and there should be a demonstrated commitment from all parties that it will be supported by the whole organization. It should cover the rosters, roles and responsibilities of managers, professional staff, contractors, those who work on planned rosters and unplanned work such as overtime and call-outs. Commuting times as well as suitability of employer-provided accommodation should also be considered.

242. Daily and weekly working hours should be arranged so as to provide adequate periods of rest which, as prescribed by national laws or approved by inspectorates or collective agreements, where applicable, should include:

(a) appropriate 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;

(d) weekly rest.

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.

243. Any changes in work schedules that could affect OSH should be preceded by full consultation with the workers and their representatives.

9.8. Work at high altitudes

9.8.1. Hazard description

244. While the proportion (or concentration) of oxygen in the atmosphere remains constant at higher altitudes, the partial pressure of oxygen decreases. For example, at an altitude of 5,000 m, the partial pressure of oxygen is only 53 per cent of its value at sea level. Partial pressure is the pressure exerted by oxygen itself, to which the human body responds. The result is that less oxygen is available to the body at higher altitudes with every breath containing fewer and fewer molecules of oxygen. The body is effectively starved of oxygen, which is referred to as hypoxia and has a number of physiological effects:

(a) hyperventilation (breathing faster, deeper or both);

(b) shortness of breath;

(c) changed breathing pattern at night;

(d) waking frequently at night; and

(e) increased urination.

These effects vary widely between individuals and are perfectly normal responses.

245. While the body can acclimatize to tolerate lower oxygen levels, this takes time. The body, in effect, balances itself, and this

probably occurs during periods of sleep. The period required for acclimatization can vary considerably between individuals and may typically be of the order of several days. From this point of balance, the body can accommodate a further increase in altitude. But there is a limit, and if it is exceeded acute mountain sickness (AMS) can result.

246. The symptoms of AMS are a headache and any one of the following:

(a) loss of appetite, nausea, or vomiting;
(b) fatigue or weakness;
(c) dizziness or light-headedness; or
(d) difficulty sleeping.

247. These are thought to be a result of a mild swelling of brain tissue due to hypoxia and can vary from mild to severe. If the swelling progresses far enough, then high altitude cerebral edema (HACE), or fluid in the brain, can result. HACE is characterized by the loss of the ability to think and possibly confusion, behavioural changes and lethargy. There is also a characteristic loss of coordination. HACE can progress rapidly and can be fatal in a matter of a few hours to one or two days.

248. Another form of severe altitude illness is high altitude pulmonary edema (HAPE), or fluid in the lungs. Although this often occurs alongside AMS, it is not felt to be related and the classic signs of AMS may be absent. Signs and symptoms of HAPE include any of the following:

(a) extreme fatigue;
(b) breathlessness at rest;
(c) fast, shallow breathing;
(d) cough, possibly producing frothy or pink sputum;
(e) gurgling or rattling breaths;

(f) chest tightness, fullness or congestion;

(g) blue or grey lips or fingernails; or

(h) drowsiness.

249. Even without severe symptoms, the low oxygen stress of altitude can impair work efficiency, performance and safety due to maladaptive behaviour, distorted consciousness and reduced sleep quality.

9.8.2. Assessment of risk

250. The assessment of the risk of working at high altitude might consider the following:

(a) the medical condition of workers expected to work at high altitudes;

(b) the experience and familiarity of the workers with high altitude work;

(c) the familiarity of workers with the body's normal response to increase in altitude (increased breathing and urination);

(d) the availability of means of rehydration for workers;

(e) arrangements to ensure that un-acclimatized workers are not put at risk (to themselves or others);

(f) workers' familiarity with the symptoms of the onset of AMS, HACE and HAPE;

(g) the degree of acclimatization of the workers;

(h) change in altitude prior to work from the altitude at which the workers were last acclimatized;

(i) the availability of first response or medical support for affected workers; and

(j) the availability of emergency evacuation to lower altitudes, if required.

9.8.3. Control strategies

251. It is common for national laws to specify the standards necessary to protect workers in opencast mines situated at high altitudes. Specific regard should be paid to the particular characteristics of these mines and the hazards to which the workers are exposed because of the location of such mines. Control strategies to prevent ill effects at high altitude might include:

(a) pre-employment and periodic medical examinations of workers, with special attention to the cardio-pulmonary system;

(b) selection of workers indigenous to high altitude;

(c) selection of workers who have shown previous capacity to work at high altitude (for example, at an altitude of 4,500 m for several weeks without appreciable problems);

(d) where workers are from lower altitudes, appropriate scheduling of periods of high altitude work considering:

(i) while many affected people feel much better after two to four days, it may take up to seven to ten days for the body's ventilatory response to stabilize;

(ii) there is potential for loss of acclimatization if workers spend too long at low altitude;

(iii) the time taken for workers to travel from their homes or sleeping quarters to the mine site (sleeping at lower altitude, if possible, is advantageous); and

(iv) psychosocial factors (although long periods working at high altitude may be the most medically efficient, they may be unacceptable socially);

(e) training of workers to understand and appreciate the symptoms of AMS, HACE and HAPE;

(f) the supply of medication (for example, acetazolamide) to assist acclimatization and improve the quality of sleep at altitude;

(g) provision to allow anyone who develops a high altitude illness to rest, to be given oxygen and, if there is no improvement, or a deterioration, to be taken to a lower altitude;

(h) occupational exposure limits, and the means of monitoring compliance with them, should be suitably modified for higher altitudes;

(i) the availability to workers of means of rehydration; and

(j) making a high altitude worksite "dry" (alcohol free).

Further information can be found in the *Encyclopaedia of Occupational Health and Safety* (ILO, online edition, 2012), Part VI, General Hazards, Barometric pressure reduced.

9.9. Tailings dams and lagoons

9.9.1. Hazard description

252. Tailings dams and lagoons contain the leftover material from the mining process, often in large quantities. Tailings are chemically similar to the parent mined material, but the presence of process reagents, evaporation of water and weathering after deposition may significantly change their properties. All tailings have been subjected in some way to physical and/or chemical separation processes, such as flotation, cyanidation or acid leaching.

253. If a tailings dam bursts it can release millions of cubic metres of potentially toxic sludge and mine waste into the nearby environment. In some cases, communities have been destroyed and lives lost. Homes, land and livelihoods have been ruined. Cleaning up and repairing damage can take many years and is a very expensive process.

254. Some common adverse characteristics of material deposited as tailings include:

(a) remnant cyanide;

(b) high pH;

(c) sulphide minerals which, through oxidation, have the potential to generate acid and consequently mobilize heavy metals;

(d) elevated arsenic levels;

(e) highly saline pore water; and

(f) colloidal clays and other suspended, or potential mobile material.

255. The more serious potential impacts associated with a tailings dam failure include:

(a) threat to human life, health or infrastructure;

(b) short-term and long-term pollution of ground and/or surface waters;

(c) raised groundwater levels resulting in salination of the surface and streams;

(d) the release of a large volume of water and semi-fluid tailings which smother vegetation, blanket the land surface and restrict stream flow with sediment;

(e) threat to the health or life of wildlife, livestock or domestic animals;

(f) loss of significant native vegetation; and

(g) generation of dust or odour.

256. The potential of these facilities to generate catastrophic accidents has been demonstrated in numerous cases. Deficiencies in design, management or operational practice, inadequate controls, unauthorized access, climatic events or geotechnical instability can reduce their safety margin.

9.9.2. Assessment of risks

257. The risk assessment of a tailings dam should take a life-cycle approach. The main phases for a tailings dam are: design, construction, operation and decommissioning.

258. Elements in the design of a large tailings dam or one storing contaminated tailings that may require consideration in the risk assessment include:

(a) location, with particular emphasis on whether the effects of failure may extend off-site;

(b) containment system;

(c) type of lifting of the dam crest; and

(d) where relevant, cyanide management.

259. Hazards associated with the operation of a tailings dam may arise through:

(a) inadequate site security;

(b) structural failure;

(c) operational failure;

(d) equipment failure; or

(e) unforeseen circumstances or consequences.

260. For instance, the main threats to the stability of an artificial embankment may be:

(a) overtopping by flood waters and overproduction of tailings;

(b) slope instability caused by high hydraulic pressure;

(c) piping of fine-grained material during seepage; or

(d) liquefaction of saturated fines during seismic activity or other vibration.

9.9.3. Control strategies

9.9.3.1. Design

261. Competent specialist engineering expertise should be assigned to oversee the entire life cycle of each tailings dam. A competent authority should oversee the entire life cycle of any tailings dam and may require the facility to be approved prior to commissioning.

262. One of the earliest and most important stages in the design of a tailings dam is the selection of an appropriate site. A proposed site for a tailings dam should be established as suitable and safe in all respects.

263. In assessing safety and suitability, particular consideration should be given to safeguarding the safety and health of workers and the nearby population during normal operation, and also in the event of a dam failure.

264. Site selection often requires analysis of a number of competing factors, some of which may be subject to national laws.

265. Matters that may be considered in assessing site selection include:

(a) the area and nature of the catchment above the tailings dam: tailings dams should be designed and located to have the smallest practical catchment;

(b) climatic conditions, such as peak flows from critical storms and wet seasons;

(c) long-term stability of structures, such as stream diversions;

(d) location of domestic water supplies;

(e) effects of drainage works on downstream flow regimes, and particularly flooding;

(f) landscape design; and

(g) planned rehabilitation outcomes.

266. Tailings dams should be adequate for their proposed use and need to be adapted to the particular site, the mineralogy and treatment of the raw material and the desired ultimate landform. The primary design objectives for a tailings dam may be:

(a) the safe and stable containment of tailings;

(b) the management of decant and rainfall run-off;

(c) the minimization or control of seepage;

(d) a cost-effective storage system; and

(e) a planned system for effective closure.

267. Appropriate investigation of the foundations of the dam and analysis of the possible causes of failure should be conducted early in the design of all tailings dams. A geological map of the area should also be prepared. The plans, sections and geological map should be kept securely at the mine.

268. Tailings dam design should meet contemporary standards and have identified and addressed all likely risks associated with the site, the nature of the containment materials, the nature, quantity and treatment of the tailings, construction process and closure.

9.9.3.2. Construction

269. Reports detailing the construction of each lift should be prepared and retained to assist determination of the overall stability and future life of a tailings dam.

270. The reports should include survey drawings of:

(a) original ground surface contours inside and outside the tailings dam;

(b) the locations of test boreholes and pits (and details of their backfilling);

(c) the location of the drainage system;

(d) the location and profiles of any borrow pits inside the facility;

(e) embankment profiles; and

(f) confirmation that the lining has been constructed to the required specifications.

271. Construction records should be retained to allow the effective monitoring of the long-term performance of a tailings dam. Ground conditions should be properly monitored and appropriate remedial works undertaken where zones of higher permeability or lower structural strength are encountered in the substrate. This information should be included in construction records. Embankment walls should be correctly keyed in. Some designs may rely on such technically complex features as grout curtains or geo-membrane liners.

272. The materials used should be appropriate and compatible with the rest of the design, emplaced to the correct compaction levels and gradient, and produce an erosion resistant outer wall.

273. Where it is necessary to vary the design during construction of a large tailings dam, it should be verified that the changes do not compromise the design objectives. The changes should be reviewed and endorsed by a suitably qualified and experienced person (such as the original designer). Changes should be reflected in all records. As a significant change could invalidate a previous risk assessment, the amended design should be reassessed and resubmitted for authorization to the competent authority.

9.9.3.3. Operation

274. Well-planned operational practices can minimize risks from a tailings dam. This should include planning for the systematic deposition of tailings, water and process chemicals in the dam. Although these processes are simple, minor variations in the way they are carried out can significantly impact on outcomes.

275. An operations manual, for utilization by operational personnel, should be in place from the time of commissioning of a tailings dam.

276. The level of detail in the operations manual should be determined by the characteristics of the specific site. However, the manual should document all relevant operational procedures, such as:

(a) roles and responsibilities;
(b) method for tailings deposition;
(c) water management and maintenance of freeboard;
(d) inspection schedule and maintenance;
(e) safety and health monitoring arising from the dam;
(f) record-keeping;
(g) reporting requirements; and
(h) any additional requirements specified by the dam designer.

277. Tailings dam personnel should have a detailed understanding of those aspects of the operations manual relevant to their day-to-day functions and responsibilities. The operations manual should be updated as required to reflect any significant changes in site conditions.

278. Monitoring and regular reviews are essential management tools for the operation of a tailings dam. Where

monitoring or reviews indicate deficiencies in the risk assessment or risk controls, there should be a clearly defined process for review of those measures.

279. Workers and other persons who work at or near tailings dams should be trained in the hazards and how to identify and report signs of failure or changing conditions that could present a risk.

280. There should be action plans in place that are activated and implemented where there are signs of failure or changing conditions identified through monitoring or reporting by workers.

281. Depending on the facility, features to be included in a safety monitoring programme for a large tailings dam might include:

(a) seepage or leakage through the embankment;

(b) cracking, slips, movement or deformation of the embankment;

(c) erosion of the embankment;

(d) pond level;

(e) pond location (location of the pond against the embankment may pose particular problems);

(f) hydraulic pressure levels in embankments (to this end, knowledge of the location of saturated ground would assist);

(g) structural defects or obstructions in infrastructure (outlet pipes, spillway, decant system);

(h) borehole groundwater elevations;

(i) under-drain flow rates;

(j) obstruction or erosion of diversion drains; and

(k) characteristics and consolidation behaviour of the tailings (enabling the prediction of final settlement and the refinement of the design to suit the predicted conditions).

9.9.3.4. Decommissioning

282. Tailings material should be securely stored for an indefinite period and present no hazard to public safety and health. The closure of a tailings dam and rehabilitation works should therefore be as inherently stable, resistant to degradation and consistent with the surrounding landscape as possible. The design should also seek to minimize upkeep.

283. Early planning for closure of a tailings dam can reduce risks for both the community and operator and minimize costs. Most tailings dams require large quantities of cover material.

284. Tailings dams should be designed for the long term and the tailings dam operator should provide for the long-term maintenance and upkeep costs associated with such facilities.

9.9.3.5. Management of cyanide

285. Sodium cyanide solutions are widely used in the mining industry for the recovery of gold and other non-ferrous metals. Industry favours cyanide because the technology is proven, well understood and available at reasonable cost. However, cyanide is highly toxic and can accumulate in the human body, plants and animals, and should be very carefully managed to minimize the associated risks.

286. In the mining industry where tailings contain cyanide, heavy metals or other undesirable constituents, seepage rates usually need to be managed by the installation of a suitable liner and often an under-drainage system. A number of options for liner construction are available, including clay and artificial liners, or a combination of both.

287. Where a liner is required for a large tailings dam or a dam storing contaminated tailings, the design process should be used to specify an appropriate design permeability and liner thickness. The design risk assessment should include consideration of:

(a) the potential rate of seepage under and through the embankment and the base of the tailings dam;

(b) the predicted chemical composition of seepage;

(c) the predicted physical and chemical properties of the tailings;

(d) the characteristics of the underlying substrate; and

(e) the potential impacts on the beneficial uses of groundwater and surface water systems.

288. Tailings dam design proposals incorporating a clay liner should specify a minimum thickness for the liner, taking the following factors into account:

(a) the thickness required to ensure construction is practicable given the need to compact in layers and minimize the development of preferential pathways;

(b) the applicability of assumptions about the degree of compaction to be achieved and the extent of homogeneity in the liner material;

(c) the permeability of the underlying substrate;

(d) the expected permeability of the emplaced tailings; and

(e) the risk of the liner integrity being compromised by cracking or mechanical damage while tailings are being deposited or prior to the commencement of deposition.

289. Tailings containing toxic chemicals, such as cyanide, can often be treated to neutralize their toxicity. However, the processing costs should be weighed against the benefits. A further consideration is that cyanide compounds degrade rapidly in the environment. Potential technologies to replace cyanide exist, but are not in wide use and are, in some cases, considered more hazardous.

290. The approach to be taken in the management of cyanide at a particular site is best determined by considering the hazards and risks applicable to the location. For example, a tailings dam within a domestic or any potable water supply catchment would need to consider the risk of contamination of water supplies. In this case it is highly likely that neutralization of cyanide would be required to adequately reduce the risk.

291. Decisions about the management of cyanide depend on a number of interacting factors. A formal hazard identification and assessment approach is needed to determine the best approach. It is also essential that this assessment be undertaken in conjunction with risk assessments for other elements of tailings dam design, such as location, water management and permeability, so that the outcomes are complementary.

292. Factors to be considered in relation to the management of cyanide include:

(a) amounts and concentration of planned and accidental possible discharge from a processing plant to the tailings dam;

(b) exposure of and impact on wildlife;

(c) contamination of surface waters;

(d) contamination of the groundwater;

(e) exposure of and impact on livestock and domestic animals; and

(f) exposure of human populations.

Exposure to cyanide can occur either directly or indirectly, for example, through human consumption of animals, plants and water that have been exposed.

293. Controls that should be considered to mitigate the risks of cyanide include:

(a) reduction or elimination of the risks of cyanide exposure to people;

(b) reduction or elimination of the amount and concentration of cyanide in tailings;

(c) animal deterrents (acoustic or visible);

(d) physical barriers to access by animals to the supernatant water, such as fencing, mesh covers or floating barriers;

(e) decant systems or seepage control to reduce the surface area of the supernatant pond;

(f) more intensive site supervision; and

(g) amendments to design criteria, such as structural design or method of deposition.

294. Further information on the management of cyanide is detailed in the International Cyanide Management Code.

9.9.3.6. Emergency response plan

295. Where an opencast mine has one or more tailings dams, the emergency response plan for the mine (see Chapter 8) should be extended to incorporate relevant provisions covering emergencies which may arise and include, as a minimum:

(a) an assessment of persons, property and environmental features at risk through the completion of a formal dam burst inundation study;

(b) engagement with local communities that may be affected about the emergency response plan and provisions, including implementation of alarms and/or warning systems;

(c) actions to be taken appropriate to the scale of the emergency, including lines of responsibility (and names and contact details of nominated safety personnel), communications, and involvement of police and emergency services;

(d) details of any necessary evacuation procedure, including the location of assembly points, in the event of failure or impending failure;

(e) accessible advice to all personnel on-site and in the community as necessary, as to the nature of the emergency warning system, or warnings and procedures to be followed; and

(f) training and refreshment programmes on safety procedures for all personnel involved.

9.9.3.7. Reporting of dangerous occurrences

296. The safety of facilities such as tailings dams can be enhanced through the sharing of experience and knowledge about accidents and dangerous occurrences. The competent authority or an entity designated by it should act as a central repository and disseminator of such information.

297. The employer in charge of the mine should make provision for the immediate notification of dangerous occurrences (including near misses) to the competent authority to allow evaluation and timely investigation. The competent authority should then circulate relevant information from reports of dangerous occurrences to other mine operators and jurisdictions, as appropriate. Relevant occurrences might include:

(a) injury or death of persons (whether legitimately on-site or not) associated with a tailings dam;

(b) injury or death of fauna (domestic or native) on or near a tailings dam;

(c) uncontrolled release of tailings or supernatant water (pipe breaks, overtopping of dam);

(d) major unplanned seepage (discernible impact on vegetation, soil contamination, groundwater accession); and

(e) defects in the structure of a tailings dam or its surrounds (cracking, slumping or significant erosion of the wall, faults in the decant system).

9.10. Tips or spoil dumps

9.10.1. Hazard description

298. Similar to tailings dams, tips contain the leftover material from the mining process, and often in large quantities. They also resemble a high wall, as a tip of any appreciable size contains a huge amount of potential energy. The unintended release of this energy can have a catastrophic outcome. In the same way as tailings dams, the impact of their failure may extend well beyond the mine site.

9.10.2. Assessment of risk

299. A similar life-cycle risk management approach to that taken with tailings dams should be adopted with tips. The design, construction, operation and decommissioning phases should be considered.

9.10.3. Control strategies

300. A competent certified engineer(s) should oversee the design, development, operation and decommissioning of a tip at an opencast mine. A competent authority should oversee the entire life cycle of any tip at an opencast mine.

301. Where it is proposed to tip mine discard or refuse of any kind, it should be established that the proposed site is suitable and safe in all respects, taking into account, where relevant, the protection of the population in the vicinity. Consideration should be given to protecting the safety and health of the population both during normal tipping operations and also in the event of a tip failure. Factors to consider in site selection for a mine tip include:

(a) mine location and future size;

(b) topography (determining the type and shape of the tip);

(c) anticipated waste rock volumes;

(d) location of property boundaries;

(e) existing drainage routes and water sources;

(f) future reclamation requirements;

(g) the condition of tip foundations; and

(h) types of material handling equipment to be used.

302. Tips should be so designed and operated as to ensure the necessary on-site safety and health. Factors to be considered in tip design include:

(a) need for compaction in design, construction and operations;

(b) the need to avoid tipping into water;

(c) tip configuration (valley fill, hillside wedges, fan and terraced dumps or some combination thereof);

(d) need to clear vegetation, soils;

(e) existing drainage routes and property boundaries;

(f) material swell factor (tip volume needed) and angle of repose (anticipated toe position);

(g) haulage method to be employed (truck, conveyor, rail) and necessary access;

(h) tip stability considerations (limits on height or slope);

(i) the need for protective berms;

(j) topographic and climatic conditions;

(k) the need for dump stability monitoring;

(l) the effects of tip "failure";

(m) design of dump points (for example, to accommodate trucks with adequate turning space and protective berms);

(n) anticipated permeability of the tip and effect on drainage;

(o) provision of adequate haul roads if required; and

(p) need for lighting at dump points or along haulage routes.

303. The employer should develop, implement and maintain safe dumping procedures for tips or spoil dumps, including for work below tips or dumps.

304. There should be an inspection and monitoring programme in place for tips to continually verify the stability of the tip, the integrity of the dump berm and the safety of dumping operations.

305. Workers and other persons who work on tips should be trained in the hazards and how to identify and report signs of failure or changing conditions that could present a risk.

306. There should be action plans in place that are activated and implemented where there are signs of failure or changing conditions identified through monitoring or reporting by workers.

307. An investigation should be conducted of the foundations and an analysis made of possible causes of failure for proposed tips. Operating procedures should be prepared for each tip and should specify a maintenance and inspection schedule and detail the problems and signs of weakness or danger in the vicinity to which attention should be drawn.

9.11. High walls

9.11.1. Hazard description

308. A high wall of any appreciable height contains a huge amount of potential energy in the rock mass. The unintended release of this energy while persons are nearby can have a

catastrophic outcome. There are basically two modes of high wall failure:

(a) rock mass failures involving a relatively large amount of material on a large portion of a high wall. These have their origins in the nature of the material and structures present. There are four types of rock mass failure:

(i) planar failures involving a sliding movement along a single discontinuity surface; however, additional discontinuities typically define the lateral extent of the failures;

(ii) wedge failures involving a sliding movement along two discontinuity surfaces that intersect at an angle forming a wedge-shaped block in the high wall face;

(iii) toppling failures involving buckling or rotational movement around the base of a slab or column formed by steeply dipping discontinuities oriented parallel or subparallel to the high wall face; and

(iv) circular failure involving rotational and sliding movement along a failure surface that occurs along numerous discontinuities and often approximates the arc of a circle; and

(b) rock falls involving a discrete number of individual rocks on a small portion of a high wall, where blocks of rock on a fragmented high wall are susceptible to falling as they are relatively unconfined.

309. Personnel exposure, block weight, drop height and high wall geometry are critical in evaluating rock fall hazards:

(a) because the block weight and drop height determine the energy of a falling rock when it strikes;

(b) because the geometry of a high wall affects how rocks fall and where they land; and

(c) slumping or sloughing of gravel, sand or other loose materials in mines including dry slumping or wet slumping (liquefaction).

310. Rock mass failure is more likely to lead to a catastrophic outcome. Rock falls can, however, also be very serious, given the energies involved, with fatalities a likely outcome in the absence of effective controls.

9.11.2. Assessment of risk

311. Knowledge of the properties of rock structure and the mine environment allows for anticipation, and often prediction of hazards, which can then be reduced or eliminated through mine layout and design. The following factors might be taken into account in assessing the risk of high wall failures:

(a) geotechnical factors, including:

(i) the depth of weathering and potential for unconfined material;

(ii) discontinuities, such as jointing or fractures, and their spacing and persistence;

(iii) the orientation of discontinuities, including dip, dip direction and strike;

(iv) bedding direction relative to a high wall face;

(v) the presence of clay material in bedding;

(vi) the length of high wall structures, with potential for splitting, and so reducing exposure;

(vii) the presence of floor rolls and a dipping seam;

(viii) the presence of major dykes, faults or burnt coal;

(ix) cracks on high wall or benches near (for example, within 10 m) of the crest;
(x) the presence of loose rocks or blocks;
(xi) the presence of wedges or overhangs;
(xii) identified zones of weakness;
(xiii) the seepage of water from face bedding or a structure;
(xiv) water accumulation at the toe;
(xv) water on top of a high wall or benches in proximity to (for example, within 30m) the crest;
(xvi) occurrence of rain or snow events;
(xvii) the head of water behind a high wall;
(xviii) the presence of spontaneous combustion; and
(xix) the integrity of dragline benches;

(b) mining factors, including:
(i) the height of a high wall;
(ii) the slope angle of a high wall in relation to mining direction;
(iii) the width of benches;
(iv) the presence of spoils on a high wall (near the crest);
(v) equipment vibrations;
(vi) blasting vibration;
(vii) the presence of burrowing animals; and
(viii) tree roots.

312. Underground mine workings in close proximity to a high wall, especially those that meet the surface in the high wall face, can cause instability. This is due to pre-existing subsidence

damage or the potential for subsidence damage in the overlying rock strata.

9.11.3. Control strategies

313. A competent and certified engineer(s) should be assigned to oversee the design, development, operation and decommissioning of a high wall opencast mine. A competent authority should oversee the entire life cycle of any high wall opencast mine.

314. Pit layout and design drawing on information from such sources as geological field mapping and core drilling.

315. High wall monitoring consists of surveillance of the high wall, either visually or with the aid of instruments. The objectives of monitoring are to:

(a) maintain a safe operation;

(b) provide advance notice of instability allowing for the timely evacuation of personnel; and

(c) provide information on the extent and rate of failure to help identify appropriate remedial measures, modify the mining plan or redesign the slope.

316. Regular and thorough examinations from all possible angles are necessary to identify potentially hazardous areas and developing conditions. Particular attention should be paid to toe and crest areas, since fallen rocks at the toe and cracks behind a high wall crest may be signs of developing stability problems.

317. Ground conditions should be examined:

(a) in areas where work is to be performed prior to work commencing;

(b) after blasting; and

(c) as warranted by ground conditions during a work shift.

318. High walls and banks adjoining travel ways should be examined as often as ground conditions warrant. It should be recognized that visual monitoring of a high wall often has limited value. Visual monitoring is often not sufficiently consistent or quantitative for informed decision-making. Spotter reaction time (considering potential fatigue), as well as means of sounding the alarm, are also critical considerations.

319. Workers and other persons who work near high walls should be trained in the hazards and how to identify and report signs of failure or changing conditions that could present a risk.

320. There should be action plans in place that are activated and implemented where there are signs of failure or changing conditions identified through monitoring or reporting by workers.

321. Monitoring with instruments can provide quantitative information on minute high wall movements. Monitoring technologies can provide this information constantly in real time. Examples of monitoring technologies include:

(a) wireline extensometers;
(b) prism surveying;
(c) global positioning systems (GPS);
(d) laser imaging; and
(e) slope scanning radar.

322. Rock stabilization and protection measures might also be employed. Stabilization measures include:

(a) reinforcement:
    (i) rock bolting;
    (ii) dowelling;

(iii) tying back walls;
(iv) shotcreting (sprayed concrete);
(v) use of buttresses; and
(vi) drainage;

(b) shot-in-place buttresses;
(c) rock removal:
(i) re-sloping;
(ii) trimming; and
(iii) scaling.

323. Protection measures include:

(a) ditches;
(b) meshing;
(c) catch fences;
(d) warning fences;
(e) rock sheds; and
(f) tunnels.

324. Benches can be used to reduce the distance rocks can fall and catch falling material. Berms can be used effectively to control rock fall hazards. They:

(a) create a catch basin to contain falling material;
(b) are also an effective barrier to keep personnel out of an area;
(c) should be properly sized and located; and
(d) should be maintained.

325. Computer modelling can be used to model rock falls to assist in the design of benches and berms. Computer models can be used to design rock fall protection measures through:

(a) modelling field conditions;
(b) applying random affects;
(c) running many simulations; and
(d) analysing patterns.

326. Exclusion zones to protect personnel should be declared, signposted or otherwise designated and enforced:

(a) in high-risk areas;
(b) at the base of high walls; and
(c) between machinery or equipment and the high wall or bank where the machinery or equipment may hinder escape from falls or slides of the high wall or bank.

327. When working is necessary near a high wall, equipment should be positioned so as to afford the operator maximum possible protection from falling material.

328. Unstable high wall conditions in the vicinity of underground mine workings could be remedied through shorter high walls and wider benches to improve the stability of the high wall by reducing overburden load, as well as the amount of material that could become unstable.

329. In cases where an opencast mine is being worked in the vicinity of any active underground workings, there should be consultation between the owners, operators or management of each mine to ensure that appropriate precautionary measures are devised and implemented.

9.12. Inundation or flooding of workings

9.12.1. Hazard description

330. Sources of large volumes of water in close proximity to opencast mine workings present a hazard of rapid inundation or flooding.

9.12.2. Assessment of risk

331. The proximity of porous water-bearing strata, dams, rivers, lakes and seas and potentially flooded underground or opencast mine workings should be considered in the assessment of the risk of inundation of opencast mine workings. In addition, the competence of intervening strata to form an effective barrier pillar should be taken into account, along with potential seismic effects.

332. When water-bearing strata are mined, workings could be flooded if the rate of water ingress overcomes water removal arrangements.

9.12.3. Control strategies

333. Prior to the commencement of excavation, steps should be taken to ensure that a thorough hydrological and hydrogeological assessment is made of the surface and subsurface conditions of the area to be mined and the area which may form a protective barrier pillar.

334. When mining in water-bearing strata or near rivers, dams, lakes and seas and potentially flooded underground or opencast mines, provision should be made for barrier pillars to be left or a dam to be erected to prevent any breakthrough. Competent specialist engineering expertise should be assigned to oversee the design and ongoing integrity of barrier pillars. A competent authority should oversee the ongoing integrity of barrier pillars.

335. No mining should take place within the boundaries of such pillars unless carefully evaluated and overseen by the competent authority. Where mining is carried out in areas liable to flooding from any source or because of any circumstance, protective schemes should be designed and implemented.

336. The protective schemes should include, where relevant, the monitoring of barrier pillars and the timely alerting of workers in the event of loss of barrier integrity.

337. In cases where a lowered water table is maintained with the aid of drainage shafts or holes, the following safety measures should be ensured:

(a) the installed pump capacity should be such that the maximum daily inflow can be raised sufficiently quickly (for example, in not more than 20 hours);

(b) stand-by pumps should be installed with a sufficient capacity (for example, not less than 25 per cent of the total installed capacity);

(c) the electrical feed to the pumps should be duplicated, with each feed capable of carrying the maximum load of the installation;

(d) stand-by pumps should be so equipped as to start automatically in case of failure of a main pump;

(e) where drainage tunnels need to be driven in water-bearing strata, pilot holes should be carried to a sufficient depth (for example, not less than 5 m); and

(f) the sump for the main pumping installation should have a sufficient capacity (for example, not less than four hours of normal water inflow).

338. Sinkholes and surface subsidence occurring as a result of dewatering should be enclosed to prohibit access.

9.13. Dredges and other floating installations

9.13.1. Hazard description

339. For the purpose of this section, the term "dredge" includes any floating vessel used for cutting, pumping, mining

or treatment purposes, and other machinery to be used for or in connection with mining by means of dredging. The term does not include a barge, workboat, tender, anchor punt or other boat ancillary to dredging operations. Dredges are, in effect, vessels used under a dynamic loading and unloading situation. The relevant hazards are therefore those of a working vessel in that situation.

9.13.2. Assessment of risk

340. The following hazard categories should be considered in the risk assessment of a dredging facility:

(a) buoyancy and stability;

(b) access and egress;

(c) drowning hazards;

(d) machinery hazards;

(e) electrical hazards; and

(f) fire hazards.

9.13.3. Control strategies

9.13.3.1. Acceptance by the competent authority

341. A dredge, floating treatment plant or other vessel should not be used in mining unless it has received the authorization of the competent authority. The application for authorization or use by the competent authority should be accompanied by:

(a) drawings and specifications of the dredge, floating treatment plant or other vessel;

(b) buoyancy calculations in respect of the vessel made by a competent person; and

(c) the results of all buoyancy tests carried out in respect of the vessel.

342. In giving authorization, the competent authority should specify the approved load line that has been assigned to the dredge or floating treatment plant. The competent authority should not assign to any vessel a load line such that the vessel would have a freeboard of less than 150 mm. The load line so assigned to a dredge or floating treatment plant should be clearly marked in an approved manner.

9.13.3.2. Personnel

343. No person should act, or be permitted or employed to act, as a winch or cutter operator unless they have been authorized by the employer, who is satisfied as to their competence.

9.13.3.3. Safety precautions on board dredges

344. The hull of a dredge or other vessel used for mining should be kept sound and watertight. The interior of the hull compartments should be kept clean and free of water as far as is reasonably practicable, with the exception of compartments in which the storage of ballast has received the approval of the competent authority,

345. A dredge or floating treatment plant should be provided with:

(a) sufficient number of lifebuoys, properly positioned on the dredge;

(b) suitable lifelines fitted around the vessel at a convenient height;

(c) a boat containing a lifeline not less than 15 m in length and a boat-hook, and equipped ready for use with oars and rowlocks or other effective means of propulsion;

(d) a sufficient number of properly fitted life vests or other personal flotation devices (PFDs); and

(e) notices indicating clearly the location of all life-saving appliances.

346. The life vests or PFDs provided should be worn by all persons when on board or when there is a danger of drowning. Their design should not impede normal activities or compromise safety when they are worn. All life-saving appliances should be maintained in good order and condition and should be kept in a readily accessible location.

347. All workers engaged on or in connection with dredgers should be given training and instruction in life-saving techniques. All dredges should be fitted with the following safety devices:

(a) an electric return signalling system between the winch room and the discharge end of the screen;

(b) an automatic alarm bell that is designed to sound when the load line assigned to the vessel has been submerged;

(c) a pendulum or other device to show the list of the vessel;

(d) a means of indicating an obstructed discharge from the dredge or treatment plant;

(e) a means of indicating the dredging depth; and

(f) in the case of a bucket dredge, an automatic device to ensure immediate stopping of the dredging machinery in the event of an overload of the dredge.

348. Warning notices should be posted in conspicuous places to warn persons of danger from head and side lines.

349. The head and side lines of a dredge or treatment plant should have free and unobstructed play between the anchors and the dredge or floating treatment plant. All obstacles likely to impede the free play of the head lines should be removed or the head lines elevated over such obstacles.

350. A deflecting sheave, if used between the anchor and the dredge or floating treatment plant, should be securely anchored. Every anchor for a head line or side line of a dredge or floating treatment plant should be of adequate capacity to hold the vessel under all working conditions.

351. No unauthorized person should be allowed to work in the vicinity of the head or side lines while the dredge is operating. No unauthorized person should be permitted to interfere with any machinery, line or other appliance used in a dredging operation.

9.13.3.4. Miscellaneous protective precautions

352. Hatchways and all other deck openings should be fitted with watertight seals or safeguarded by coamings not less than 400 mm in height, to prevent water ingress. All openings a person could fall into should be closed or guarded. Hull compartments should be treated as confined spaces, if applicable.

353. The competent authority may require every open side of the deck of a dredge or floating treatment plant to be provided with guardrails and stanchions suitable to prevent persons falling overboard. The following provisions should apply to all guardrails:

(a) stanchions should be secured to the deck and spaced not more than 5 m apart;

(b) the guardrails should consist of an upper rail located 1 m above the deck and a lower rail located 250 mm above deck;

(c) guardrails should be constructed of suitable timber, scaffold tube, steel wire rope or chain and, in the case of steel wire rope or chain, should be kept taut by means of turn-buckles or other suitable devices; and

(d) guardrails should be kept in place except when removed temporarily for access purposes.

354. Where the competent authority directs, a dredge or floating treatment plant working close to a bank should be provided with a gangway not less than 600 mm wide and of sufficient length to reach from the bow to a firm and stable position on the bank, or from the stern to the tailings dump, according to the instructions of the competent authority. The gangway should be provided with a substantial handrail and should be secured to the deck of the dredge or floating treatment plant.

355. Every place where persons are working should be adequately illuminated during the hours of darkness.

356. The following safety requirements should be observed by all persons working on a dredge used for mining purposes:

(a) every member of a dredge crew when employed in outboard work on the dredge should use safety belts, life jackets and personal floatation devices, and what to do in the event of falling into the water;

(b) in the event of a person going overboard, the bucket line or cutter and suction equipment should be stopped immediately and the alarm given; and

(c) no person should step on any bucket, chain or revolving screen while it is in motion, nor ride on them.

357. The employer should appoint a competent person to carry out specific inspections and controls daily before the commencement of operations, namely:

(a) soundings of all hull compartments;

(b) inspection of the freeboard on the bow, stern, port and starboard; and

(c) inspection of the dredging depth or ladder angle, in a bucket dredge where the dredging depth is not recorded automatically.

358. The person who makes the checks should record the results forthwith in a durable manner determined by the employer.

9.13.4. Emergency provisions

359. Immediately after the sounding of any emergency alarm, the winch operator or other person in charge of the dredge or other vessel concerned should:

(a) cease digging or dredging and take all necessary measures to correct the defect causing the alarm; and

(b) not recommence digging until the defect triggering the alarm has been effectively corrected.

360. After the operation of the automatic overload stopping device, digging should not be permitted to recommence until the winch operator has ascertained that the overload has been cleared.

9.13.5. Other matters

361. The maximum number of persons that may be carried at one time in a dredge or other vessel used in connection with dredging or mining operations should be fixed by the competent authority. A prominent notice of this figure should be kept posted on the dredge or other vessel.

362. Warning notices for the public should be posted in a conspicuous position in all cases where head or side lines cross a path or thoroughfare.

363. Every dredge should be provided with suitable toilets or latrines.

364. All dredges and other floating installations should be provided with firefighting facilities in a quantity to be agreed with the competent authority.

9.14. Surface buildings and structures

9.14.1. Safety of buildings

365. All buildings and structures should comply with the requirements of national building laws, regulations and accepted standards, including all standards for access ways, platforms and electrical wiring. They should be maintained in safe condition and, wherever possible, be constructed of fire-resistant material.

9.14.2. Safe means of access

366. Safe means of access to or egress from every place or building where any person has to pass or work should be provided and maintained in good condition.

9.14.3. Provision of emergency lighting

367. Stand-by emergency lighting should be provided for use in the event of a failure of the power supply:

(a) at the medical or first-aid room and, where appropriate, the rescue station;

(b) at changing rooms and wash houses;

(c) in crusher houses and treatment plants where stairways, walkways or ladders are normally used by operating personnel;

(d) at all stairways and emergency escape ways; and

(e) at all places where a reduction or failure of artificial illumination is likely to result in enhanced risk to the workers employed there.

368. The competent authority may grant exemption or relief from the provisions of this section if workers are not present during the hours of darkness or where individual lamps are provided.

9.15. Management of falling hazards

9.15.1. Hazard description

369. Hazards associated with a fall by a person from one level to another that is reasonably likely to cause injury to the person concerned or to any other person should be marked with appropriate signs and controlled.

9.15.2. Assessment of risk

370. These hazards include work:

(a) in or on an elevated workplace from which a person could fall;

(b) in the vicinity of an opening through which a person could fall;

(c) in the vicinity of an edge over which a person could fall; or

(d) on a surface through which a person could fall.

9.15.3. Control strategies

371. Where any person can fall a hazardous distance or any distance which may be specified in national laws, secure footholds, handholds and fences should be provided as necessary to control that hazard. Where these provisions are not practicable, safety harnesses, or other fall-prevention and fall-arrest devices should be provided and used.

372. Where there is a risk of falling objects striking a worker, suitable control measures should be implemented.

9.16. Falls from height and falling objects

9.16.1. Hazard description

373. Falls from a height above ground or platform level are a major cause of serious injuries and fatalities in opencast mines. This can occur when:

(a) persons working at a height above ground or platform level are not prevented or protected from falling and fall to below;

(b) persons accessing areas, machinery or equipment, including ascending, descending or working on ladders, among other things.

(c) incorrect operation or failure of height access or fall-arrest equipment; and

(d) a person being suspended in a harness after a fall from height has been arrested by fall-protection equipment and the person is not rescued in time, resulting in suspension trauma.

374. Objects falling from height and striking a person are also a major cause of serious injuries and fatalities in opencast mines. This can occur when there is an unplanned release from height of an object, including equipment, components, tools, material, among other things, and persons are in the drop zone or working below.

9.16.2. Risk assessment

375. The competent authority should establish regulations, specifying requirements for fall prevention or work at height. This should include the requirements for preventing falls from height; the certification, inspection, testing and use of fall-prevention and fall-protection equipment; and the required controls to prevent falling objects striking a person.

376. The employer should perform a risk assessment to identify and assess tasks that involve a risk of a person falling from height. Based on the risk assessment, there should be a fall-prevention programme developed. The programme should include:

(a) procedures for working at height;

(b) a process for preparing, testing and implementing emergency rescue procedures for fall scenarios; and

(c) the certification, provision, use inspection, testing and maintenance of fall-prevention and fall-protection equipment.

377. The employer should perform a risk assessment to identify and assess the situations, tasks or equipment where there could be an unplanned release from height of any object, equipment, component or material, among other things. Particular attention should be paid to work, either routine or non-routine, where persons are working above other persons. Based on the assessment, each mine should develop control strategies for the prevention of falling objects or for protecting persons from the risk of falling objects.

9.16.3. Control strategies

378. In all cases, elimination of the risk of a fall from height is the priority and there should be processes in place to assess the work and minimize the need for working at any height, including bringing components to ground level to perform maintenance, among other things.

379. In any case, where there is a risk of falling greater than the height specified by national regulation (for example, 1.8 m is typical), either fall-prevention or fall-protection equipment should be used.

380. Where work at height occurs, the employer should develop work at heights procedures and a permitting process. This should include a process for preparing, testing and implementing emergency rescue procedures for fall scenarios.

381. The employer should develop a procedure to define barricading requirements where there is a risk of falling over an unprotected edge and barricading or protective covers where there is a risk of falling through an opening. The procedures

should also address the control measures required to prevent or protect a person from falling through a brittle surface, for example, working on or accessing roofs, among other things.

382. Where elimination of the fall risk is not possible, there should be a process to reduce the risk of falling by using fall-prevention measures that include:

(a) fixed and temporary work platforms, access ways, barriers, and so forth, including scaffolding and mobile work platforms, among other things; and

(b) fall restraint, which should only be used when elimination of the fall risk, the use of work platforms or hard barricading cannot be used. Fall restraint should prevent a person reaching a position at which there is a risk of a fall and should consist of a harness, connected by a lanyard to an anchorage point or static line.

Fall-prevention measures should be designed, installed, maintained and certified in accordance with national laws and by competent, authorized persons. There should be processes and procedures for the inspection, maintenance, testing and certification of these.

383. Wherever practical, a safe working area should be provided by means of work platforms or scaffolds that have complete floors, guardrails, toe-boards, and safe access and egress.

384. Where mobile work platforms are used for fall prevention, there should be a process for ensuring these are compliant with national laws and approved standards and that they are inspected to manufacturers' pre-operational check requirements prior to use. When operating a mobile work platform:

(a) a competent and authorized person should be designated to control the mobile work platform and that person should be inside the basket; and

(b) every person in the mobile work platform basket should be attached to an approved anchorage point at all times.

385. Where the above fall-prevention strategies cannot be used, fall-protection or fall-arrest systems should be used. A fall-arrest system should only be used where a person:

(a) can reach a position where a fall is possible;

(b) has a lanyard, adjustable in length, so the unprotected edge can be reached; and

(c) is working on a surface that may not hold their weight.

386. The fall-arrest system should consist of:

(a) an approved body harness;

(b) a shock-absorbing lanyard, where the potential to fall is greater than 4 m or a short restraining lanyard, where the potential to fall is less than 4 m;

(c) double- or triple-action snap hooks (or karabiner type rings); and

(d) secure anchorage points or static lines.

387. There should be a process for ensuring that fall-arrest equipment, including harnesses, shock-absorbing lanyards, hooks or rings is tested and certified for use; inspected by the user before use; and destroyed after a fall or where inspection shows evidence of excessive wear or mechanical malfunction.

388. Permanent anchorage points should be designed and rated to take the required load and be periodically inspected by a competent person. Temporary anchorage points must be assessed by a competent person prior to use to ensure they can support the required load.

389. Work from portable ladders should be minimized. If required, it should be carried out in accordance with an approved procedure. Portable ladders should be safely stored, inspected

before use and maintained. A person may climb or descend a ladder without fall protection provided that they are able to use both hands and legs to do so; facing the ladder, and using one step at a time. Where a person could fall more than 6 m, a fixed ladder installation should be fitted with a side screen, or a ladder cage.

390. Where overhead work is being conducted, barricading should be erected around the work area to prevent people accessing the drop zone and there should be controls in place to prevent tools, equipment or other objects from falling.

391. There should be training and competency assessment in accordance with national laws, regulations and approved standards so that relevant persons are trained and deemed competent to:

(a) work at heights;

(b) issue work at heights permits;

(c) design, erect, dismantle, maintain and inspect work platforms and scaffolds;

(d) design, install, inspect and maintain anchorage points and static lines;

(e) operate and maintain mobile work platforms; and

(f) inspect and maintain scaffolding and work at heights equipment.

9.17. Confined spaces

9.17.1. Hazard description

392. A confined space is an enclosed or partially enclosed space that is not designed or intended for continuous human occupancy and at any time during entry, occupancy or exit can have a hazardous atmosphere, risk of engulfment or entrapment, for example a tank, process vessel, underground vault or tunnel. A person would only enter if there was work to be done.

393. While the primary hazard of confined spaces is the atmosphere that they may contain, they are also sometimes cramped spaces which may hinder entry, exit and the activities of a person working in them. Many fatalities occur when first responders, without adequate precautions or personal protection, enter confined spaces in an attempt to rescue colleagues.

9.17.2. Assessment of risk

394. In assessing the risk posed by confined spaces at an opencast mine:

(a) existing and potential confined spaces should be identified by a person familiar with the hazards of confined spaces who is assigned to conduct that identification;

(b) a register of all identified and potential confined spaces should be compiled and maintained and made available to all workers at the site;

(c) where entry is not required, unauthorized or inadvertent entry into a confined space should be prevented by posting warning signs, locking and securing, or other measures as necessary, to ensure that workers do not enter without proper protection;

(d) where entry is required by a worker:

(i) a confined space should be fully characterized, through testing and inspection, for all existing and potential hazards in the confined space (hazards can be classified as mechanical, oxygen depletion, flammable or combustible vapours and gases, and toxic gases and vapours); and

(ii) supply systems to a confined space should be blanked off or bled and isolated.

395. A confined space should be re-evaluated where there is reason to believe that conditions have changed.

9.17.3. Control strategies

396. Because of its hazardous nature, work in confined spaces is often addressed in national laws and accepted standards. Measures should be taken to identify any relevant laws and accepted standards and to follow them.

397. Workers who are to enter a confined space, and those who are to act as sentries to protect them, should be trained and competent in confined space entry. Where a competent authority requires certification for confined space entry, those workers should be appropriately certified.

398. All identified confined spaces should be clearly marked with warning notices and means provided to prevent unauthorized entry. Lone entry into confined spaces should be clearly prohibited and enforced.

399. No confined space entry should be permitted before site-specific confined space entry, work and emergency procedures are implemented. Confined space entry should be controlled by a permit system with an appropriate level of authorization.

400. Prior to any entry into a confined space, the atmosphere should be tested to ascertain its content. It should never be assumed that a confined space remains in the same state as it was left after the last entry. If the atmosphere in a confined space does not appear safe, then all reasonable measures, including purging, inerting, flushing or ventilating should be undertaken to make it safe (based on retesting as appropriate). All supply systems to the confined space should be turned off, blanked off or bled prior to entry.

401. Workers entering a confined space should be provided with appropriate respirators and PPE commensurate with the hazards in the confined space. Forced ventilation should be used to reduce the potential for build-up of toxic or flammable gasses or vapours in the confined space.

402. Not less than two persons should be present when there is work in a confined space. One should be outside the confined space to keep watch and to offer rescue action or assistance or to activate emergency arrangements; that person shall have no other assignments. Additional emergency and accident assistance should be readily available. Testing of the atmosphere in a confined space should continue while work proceeds and persons in the confined space should leave immediately if told to do so. Rescue harnesses should be worn by everyone inside the confined space, with lifelines attached to a point outside the space, where a risk assessment identifies the need.

9.18. Machinery

9.18.1. Hazard description

403. All machines can be the source of diverse hazards and great attention should be paid to their design, manufacturing, planned use, maintenance and disposal.

404. To ensure that machines are safe, key decisions have to be taken already at the concept/design and manufacturing stages. This code does not cover these decisions, as the steps to be taken by designers and manufacturers of machines are not undertaken at opencast mines. It is, however, recommended that the guidance in the ILO code of practice *Safety and health in the use of machinery* (Geneva, 2013) (the "Machinery code") should be followed by designers and manufacturers of machines for opencast mines, as well as considered by employers, when choosing machinery.

9.18.2. Assessment of risk

405. In ensuring safety in the use of machinery by reducing the associated risks, risk assessments should be conducted at various levels. Risk assessment should be completed by employers to ensure that the machinery is safe and to provide a safe system of work, and workers should be consulted to secure their views and experiences, and should actively participate in risk-assessment procedures.

406. Safety and health risks can be assessed as follows:

(a) collecting the appropriate information, including manufacturers' information, and determining the limits of the machinery, such as use, speed, time, environmental and interface limits;

(b) performing a risk assessment to identify and document the hazards associated with the tasks to be performed for the use and maintenance of machinery in the workplace; and

(c) developing and implementing procedures specifying controls for the operation and maintenance of the machine.

407. Risk assessments to ensure safety in the use of machinery should cover the following aspects:

(a) adequacy of initial machinery design;

(b) correct selection of machinery;

(c) adequacy of machinery installation;

(d) correct use;

(e) adequate maintenance;

(f) management of changes in personnel, materials and work methods; and

(g) equipment and process modifications.

408. Employers should consider the workers affected when identifying tasks and hazards. These may include: operators and

helpers; maintenance individuals; engineers; technicians; sales personnel; installation and removal personnel; administrative personnel; trainees; passers-by; designers; managers; supervisors; safety personnel; safety committees; safety consultants; and loss control administrators. In addition, employers should determine the level of knowledge, training, experience and ability of such persons.

409. In assessing the risks, employers should consider typical categories of hazards and hazardous situations, such as: (1) mechanical; (2) electrical; (3) thermal; (4) noise; (5) vibration; (6) radiation; (7) materials and substances; (8) ergonomic; (9) unexpected start-up, overrun and overspeed; (10) inadequate stopping; (11) rotating parts; (12) power supply failure; (13) control circuit failure; (14) errors of fitting; (15) break-up during operation; (16) falling or ejected objects or fluids; (17) loss of stability and overturning of machinery; (18) slipping, tripping and falling; and (19) combinations of the above. Further information on these hazards and respective control measures are found in Chapters 3–17 of the Machinery code.

9.18.3. Control strategies

410. In addition to the general provisions outlining control strategies in the Machinery code, Chapter 8 of that code outlines supplementary measures relating to specific machinery types. Section 8.4. Dealing with machinery presenting hazards due to its mobility (such as vehicles, earth-moving machinery, excavators) is of particular relevance to users of the present code. As the Machinery code does not comprise a similar section on boilers, Appendix IV of the present code provides such information. It should be read in conjunction with the Machinery code.

9.19. Tyre and rim safety

9.19.1. Hazard description

411. Off-road tyres used on much opencast mining machinery are potentially hazardous because of:

(a) their large size and mass. The greatest fatality risk potential is from tyres with a diameter greater than 24 inches or those with split rim assemblies;

(b) the magnitude of air or gas pressures they contain; and

(c) the presence of combustible materials along with a source of ignition in case of a tyre fire (with potential for explosion).

412. The uncontrolled release of the mechanical, pressure or chemical energy inherent in tyre assemblies can result in serious accidents, including fatalities.

413. The hazards associated with tyres include:

(a) those related to inflating and deflating, handling and working with tyres, wheels and rims, including pneumatic tools;

(b) tyre fires, bursts and explosions when tyres are in service; and

(c) loss of control of a vehicle due to tyre failure.

414. Caution: an overheated large tyre should be regarded as a "ticking bomb". An explosion in a large tyre can propel debris hundreds of metres and is potentially lethal to any workers in the vicinity, including persons in vehicles. In addition, tyre fires are difficult to extinguish and produce large volumes of toxic fumes.

9.19.2. Risk assessment

415. Effective tyre management needs to consider the life cycle, selection, operation, maintenance and disposal of tyres,

rims and wheel assemblies. A strategy that spans the whole life cycle needs to involve the employer, suppliers and manufacturers, maintenance workers and OSH experts.

416. A risk-based approach to tyre safety might consider:

(a) information on tyre and rim failures (for example, circulars from a competent authority or other industry information);

(b) records of tyre use and failure at the mine;

(c) the influence of mine operations on tyre life and safety;

(d) the sudden release of stored pressurized energy, leading to projectiles (for example, rim components or rocks) and percussive shock;

(e) the use of compressed air or other gases (for example, nitrogen) with pressure hazards and, in the case of nitrogen, asphyxiation and cryogenic hazards;

(f) noise from, for example, the rapid release of compressed gases, working with pneumatically powered tools and general workshop noise;

(g) the handling of heavy objects, for example, tyre assemblies weighing many tons;

(h) working with or operating heavy equipment such as cranes, forklifts or mobile plant fitted with hydraulic tyre-handling attachments;

(i) low-inflation pressure damages a tyre in a number of ways, including:

(i) heat separation caused by over work;

(ii) irregular wear of the tread caused by excessive tread movement;

(iii) separation caused by excessive sidewall distortion;

(iv) friction and chafing caused by distortion of the bead area or slipping of the bead; and

(v) separation of plies due to high stress between plies; and

(j) heating of any part of a tyre assembly, wheel end or hub can compromise the integrity of the tyre, and in extreme cases result in bursting or explosion (due to pyrolysis of the tyre material, or decomposition of inappropriate lubricant or wooden debris left inside a tyre).

417. Sources of tyre heating that could result in an explosion include:

(a) heating of frozen wheel fasteners;

(b) welding or grinding of wheel components;

(c) contact with high-voltage electrical conductors (for example, overhead power lines);

(d) a lightning strike; and

(e) external fires (for example, engine bay fires, hydraulic fires, electric fires, or grass fires in parking areas).

418. As tyre degradation may not be detectable, it can lead to auto-ignition without warning. Moreover, some fuels, solvents and other hydrocarbons may react with tyre rubber and increase the risk of fire.

419. The use of thermal imaging or remote tyre pressure monitoring (for example tyre pressure/temperature monitoring systems) avoids the need for personnel to enter the danger zone of a suspected overheated tyre to conduct an initial assessment.

9.19.3. Control strategies

420. Control strategies to be considered include:

(a) assessing and preparing appropriate storage and work areas;

(b) selecting and implementing tyre-handling facilities, including plant, tools, equipment and safe work procedures;

(c) monitoring and implementing component inspection, maintenance and repair (for example, non-destructive testing of wheels and rims);

(d) appropriately assessing and selecting tyres, wheels or rims;

(e) maintaining accurate record-keeping of tyre and rim service;

(f) understanding the mechanisms of tyre fires and explosions;

(g) minimizing the risk of tyre explosions, by considering:

(i) remote deflation and inflation of tyres during maintenance from a protected or guarded position;

(ii) tyres on split rims or those with tubes should be deflated to zero PSI or other tires to a maximum nominal pressure of 5 PSI (0.3 bar) prior to removal of any retaining devices;

(iii) all lock rings should be identifiable to ensure compatibility with rims and be inspected prior to fitment to ensure they are fit for purpose and checked for correct seating prior to inflation;

(iv) replacing compressed air with nitrogen gas for inflation, provided the correct nitrogen inflation procedure is used so that the tyre is sufficiently purged of air;

(v) ensuring overhead power lines crossing haul roads have adequate clearance and warning signs;

(vi) providing lightning notifications to reduce the potential exposure of vehicles to lightning strikes;

(vii) avoiding the use of petroleum-based products on or near tyres;

(viii) operating tyres within the manufacturer's specifications; and

(ix) not using a lubricant to assist with assembling tyres and rims unless it has been clearly identified by the manufacturer as being safe to use for that purpose;

(h) parking up trucks that have or are suspected to have overheated tyres in a safe place well away from other equipment and workers, and allowing tyres to cool down slowly over at least 24 hours before any inspection or replacement of the tyre is attempted;

(i) providing appropriate emergency response procedures and capability; and

(j) ensuring that people are trained for the tasks they are assigned.

421. A competent person should be assigned to oversee the selection, operation, maintenance and disposal of tyres, rims and wheel assemblies at opencast mines.

9.20. Fires on large machinery

9.20.1. Hazard description

422. The opencast mining industry is characterized by the use of large diesel or diesel/electric powered machinery (for example, haul trucks, bulldozers or excavators). There is typically enormous potential for fire to occur on these machines with an ample supply of fuel, in the form of diesel, and myriad potential sources of ignition. As well as rapidly engulfing an entire machine, a serious fire can put the machine operator at extreme risk.

9.20.2. Assessment of risk

423. Each type of large mobile machinery in use, or to be used, at an opencast mine should be the subject of risk assessment focused on potential fuel and ignition sources as precursors to a fire. In addition, the risk assessment should consider the hazards to which a machine operator may be exposed in the case of fire.

9.20.3. Control strategies

424. Control strategies should be considered to include:

(a) training of workers in the use of fire extinguishers and fire suppression systems;

(b) fitting of fire detection and suppression systems;

(c) fire detection and suppression systems as well as fire extinguishers should be maintained on a scheduled basis;

(d) fitting of handheld fire extinguishers readily available to the machine operator;

(e) machine operator protection and rapid and safe means of egress;

(f) the use of metallic fuel tanks and steel braided fuel lines in preference to plastic;

(g) routing of fuel lines away from high risk/temperature areas and sources;

(h) segregation of fuel lines from damage and potential fire risks;

(i) separation of fuel lines and electrical cables;

(j) adequate protection and support of components to mitigate vibration damage;

(k) shrouding of hot parts;

(l) shielding of vulnerable parts, for example, rubber hoses;

(m) removal of undesirable exposed materials (for example, cladding or inappropriate insulation);

(n) control of foreign material (for example, rags, debris, oil spills, dust accumulation, food wrappers or drink cans);

(o) washing of vehicles at appropriate intervals;

(p) use only of fit-for-purpose machines;

(q) appropriate operational demands on machinery (for example, operating conditions, loads or grades);

(r) timely rectification of leaks (for example, hydraulic and lubricating oil or fuel);

(s) timely rectification of electrical faults; and

(t) adequate machine inspection and maintenance generally.

9.21. Automated machinery

9.21.1. Hazard description

425. A common rationale for introducing automated machinery includes improving safety by the removal of the human element, thereby reducing the exposure of workers to hazards. As new technologies change the risk profile of mining operations, the risks introduced by automated machinery need to be assessed in great detail and the respective control measures taken.

426. In opencast mines, automated machinery can currently include:

(a) facilities to load and unload trains;

(b) mobile crushing and screening plants;

(c) excavators and shovels;

(d) loaders;

(e) bulldozers;

(f) haul trucks;

(g) drill rigs; and

(h) light vehicles.

427. Hazards with automated machinery are likely to arise:

(a) if the machinery strays outside its planned operating envelope;

(b) if personnel stray into the operating envelope of automated machinery; and

(c) when personnel are in close proximity to automated machinery for maintenance or repair purposes.

9.21.2. Assessment of risk

428. The employer should conduct a comprehensive mine-site risk assessment prior to the introduction of automatic machinery, which should take the following aspects into consideration:

(a) adequacy of initial machinery design (including its functional design and machinery safety and security);

(b) correct selection of machinery in view of the mine design and existing limits of machine capabilities;

(c) adequacy of machinery installation, including detailed management of interactions and interfaces between automatic and manual machinery;

(d) planning for automatic operation, setting up specific operational practices for correct use and for necessary support logistics;

(e) adequate maintenance, including repair facilities and practices;

(f) managing changes in personnel, materials and work methods, including rules on how to revert to manual operation, if required; and

(g) equipment and process modifications.

9.21.3. Control strategies

429. The automation of large mining machinery, catering for its interactions with the working environment and other machinery, and the development of appropriate support expertise, are challenging tasks. The introduction of new technologies therefore has the potential to disrupt work organization and shift responsibilities.

430. Competent persons with the required technical skills should be available at each mine to oversee the deployment of machines and the implementation of all related control strategies.

431. All machines should be:

(a) compliant with accepted standards (including in relation to the functional safety of critical systems);

(b) provided with layers of protection and redundancy built into safety systems (for example, collision avoidance);

(c) designed to prevent unauthorized (or unintended) modification of operating parameters;

(d) designed to use fail-to-safety and safe machine degradation approaches;

(e) designed to ensure the integrity of control to machine communications;

(f) licensed (for example, for communications networks); and

(g) provided with the technical information as to their design and use.

432. All control strategies should take into account specific capabilities and limits of each machine in relation to, for example:

(a) functioning under harsh operating conditions (for example, heat, dust, vibration);

(b) operating gradients and surfaces; and

(c) turning radiuses.

433. The interactions between automatic and operated machinery should be devised in a way that:

(a) minimizes interaction between personnel and non-automatic machines (for example, through separation of automatic machines from personnel and manned machines; separate park and work areas; access controls to and from automated machine operating areas); and

(b) minimizes their potential for interaction with explosives and processing facilities.

434. Operational and management practices should be established in relation to:

(a) traffic management (including road design, intersections, park-up areas, loading and dumping locations and speed limits);

(b) review and sign-off processes for system changes to ensure strict control thereof (for example, software or firmware);

(c) ensuring that machines are provided with a valid mine model that reflects the most recent changes; and

(d) commissioning, maintenance and repair, including in relation to:

(i) conduct of safety system and machine performance tests;

(ii) formal commissioning and hand-over processes;
(iii) controls for in-situ inspection and servicing;
(iv) safe recovery procedures in case of breakdown;
(v) effective isolation of servicing or recovery areas; and
(vi) safe procedures for reversion to manual operation, if required.

9.22. Electrical equipment

9.22.1. General provisions

435. Electrical equipment should only be installed in a manner consistent with national laws or accepted standards. Sufficient numbers of suitably certified and competent persons should be assigned to develop, implement and maintain all electrical equipment in conformity with those requirements or standards. Such persons should be competent to a level commensurate with any qualification requirements of a competent authority.

436. Small mines might consider pooling their resources with other mines, or making other appropriate arrangements to enable them to comply with the relevant requirements.

437. An electrical control plan respecting all the electrical equipment at the mine of whatever description or purpose should be prepared and implemented. The electrical control plan should cover:

(a) the examination and testing of all electrical equipment before use, after installation, reinstallation or repair;

(b) the systematic examination and testing of all electrical equipment at the mine to ensure its proper maintenance, including ensuring that accumulation of dust is not permitted;

(c) the intervals, which may differ for different equipment and parts of equipment, within which all electrical equipment should be examined and tested;

(d) the nature of the examination and testing to be carried out; and

(e) the manner in which the results of every examination and test made pursuant to the control plan are to be durably recorded.

438. No one, except a competent person or persons working directly under their close personal supervision, should undertake any electrical work where technical knowledge or experience is required.

439. Notices should be posted at prominent positions around the mine:

(a) prohibiting any unauthorized person from handling or interfering with electrical equipment; and

(b) setting out directions as to the rescue and first aid of persons suffering from electric shocks or burns.

440. Electrical installations should be protected from inadvertent access by fencing or locked installations, and appropriate warning signs posted.

9.22.2. Insulation

441. All power wires and cables should be adequately insulated where they pass into or out of electrical compartments. Cables should enter metal frames of motors, splice boxes and electrical compartments only through proper fittings. When insulated wires, other than cables, pass through metal frames, the holes should be substantially bushed with insulated bushings.

442. Communication conductors for telephone and low-potential signalling systems should be protected by isolation or

suitable insulation, or both, from contacting energized power conductors or any other power source.

443. High-voltage electrical conductors should be covered, insulated or so placed as to prevent contact with low-voltage conductors. The voltage on bare signal wires accessible to contact by persons should not exceed a safe voltage (for example, 48V). In the selection of insulating material, consideration should be given to the conditions under which the conductors will be used.

9.22.3. Control devices

444. All electrical equipment and circuits should be provided with properly designed switchgear to facilitate control and, when necessary, isolation or lock-out. Principal power switches and terminals should be appropriately labelled to show which units they control.

445. Control devices need to be maintained and inspected at regular intervals.

446. Where a motor is operated by means of remote control and is stopped from any point, the circuit should be so arranged that the motor cannot be started again except at the place from which it was stopped.

9.22.4. Distribution boxes

447. Distribution boxes should be provided with a disconnecting device for each branch circuit. Such disconnecting devices should be equipped or designed in such a manner that it can be determined visually when the device is open and the circuit de-energized. Distribution boxes should display single-line wiring diagrams and be labelled to show which circuit each device controls.

448. Inspection and cover plates on electrical equipment and junction boxes should be kept in place at all times, except during testing or repair.

9.22.5. Earthing systems

449. All earthing conductors should be electrically continuous throughout, and in effective electrical connection with earth and with the equipment they are intended to earth. Individual earthing conductors should be connected in parallel and it should be strictly forbidden to connect them in series.

450. All metal enclosing or encasing of electrical circuits should be earthed or provided with equivalent protection. This requirement does not apply to battery-operated equipment.

451. Frame earthing or equivalent protection should be provided for mobile equipment powered through trailing cables. Metal fencing and metal buildings enclosing electrical apparatus should be earthed.

452. A specific requirement should be established within the scheme of maintenance for verifying resistance and continuity of earth leads and establishing that the maximum resistance specified in national laws or accepted standards is not exceeded.

9.22.6. Overload and earth leakage protection

453. 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. Fuse links of all fuses should be calibrated by the manufacturer and the rated current should be indicated.

454. The use of unmarked or uncalibrated fuses, or defeating fuses or bridges, should be prohibited.

455. The conditions under which automatic earth leakage current protection is required together with the current levels at which the protection should operate should be defined and applied (for example, each circuit supplying portable electrically operated hand-held equipment should operate at no more than 250V and have earth leakage current protection of no more than 30mA at 30 milliseconds sensitivity).

9.22.7. Transformers

456. Transformers should be suitably housed and, where necessary, fenced. Transformer enclosures, where provided, should be kept locked against unauthorized entry.

457. Any transformer, installed for the first time, should not contain polychlorinated biphenyls (PCBs) or other materials likely to release toxic gases when ignited. Inservice transformers containing these materials should be removed from service and marked as PCBs and disposed of responsibly as soon as practicable.

9.22.8. Conductors

458. Conductors or wiring, and the conditions under which they are installed and used, should be in accordance with national laws and accepted standards.

459. All overhead power lines should be constructed and maintained in accordance with national laws and accepted standards.

460. Temporary overhead power lines in opencast mines should conform to the following requirements:

(a) a table of distances of the lowest phase wire of a power line to the ground should be prepared;

(b) no piles of rock, ore, sleepers, rails or other materials should be made below overhead power lines; and

(c) no excavator or other machine with extensible or lifting arms should be used under or near power lines unless the lifting or extending part of the machine does not approach nearer than a safe distance from the power lines (for example 1 m for lines up to 1 kV, 3 m for lines up to 33 kV, 6 m for lines up to 132 kV, or 7 m for lines up to 400 kV. Where the rating is unknown, the distance should be no nearer than 6 m).

461. Any work in the vicinity of overhead power lines should be the subject of a risk assessment prior to commencement.

462. Trailing cables should be attached to machines in a suitable manner to protect the cable from damage and to prevent strain on the electrical connections. Surplus trailing cable on excavators, cranes and similar equipment should be:

(a) stored in cable boats;

(b) stored on reels mounted on the equipment; and

(c) otherwise protected from mechanical damage.

463. While it should be avoided, workers who have to manually handle trailing cables in the course of their duties should be provided with the necessary equipment, such as insulated hooks, tongs, gloves and aprons for this purpose. Trailing cables feeding mobile machinery should be so laid as to avoid being damaged, run over, or freezing to the ground. In inundated areas, cables should be laid on supports.

464. A cable that has been mechanically damaged should be taken out of service as soon as possible. Notwithstanding this provision, a damaged cable may remain temporarily in use only if it is examined by a person with appropriate electrical expertise and rendered safe. Any cable requiring repair should be disconnected from the feed point and any residual electrical charges should be discharged. All overhead and cable power lines located within the danger zone during blasting operations should be de-energized during the blast, and should be inspected before being re-energized.

465. Electric power lines should not be worked on during thunderstorms.

466. Permanent splices and repairs made in power cables, including the earth conductor where provided, should be:

(a) mechanically sound and with electrical conductivity which is not significantly less than that of the original;

(b) insulated to a degree at least equal to that of the original, and sealed to exclude moisture; and

(c) provided with damage protection as near as possible to that of the original, including good bonding to the outer jacket.

467. Power cables energized to potentials in excess of 150V, phase-to-earth, should not be moved by equipment unless sleds or slings insulated from such equipment are used. When such energized cables are moved manually, insulated hooks, tongs, ropes or slings should be used unless suitable protection for persons is provided by other means. This does not prohibit the pulling or dragging of a cable by the equipment it powers when the cable is physically attached to the equipment by suitable mechanical devices, and the cable is suitably insulated from the equipment.

9.22.9. Switchboards and switchgear

468. Switchboards and switchgear should be so installed, located and guarded that:

(a) the control means are safely and readily accessible to authorized persons;

(b) live parts are inaccessible to unauthorized persons;

(c) adequate working space is provided for manual operation where required, including at the back of any switchboard having exposed live parts lower than 2.5 m from the ground; a clear space of not less than 1 m is provided between the top of the equipment and any ceiling having exposed combustible material;

(d) adequate illumination is provided;

(e) interrupting capacity adequate to handle the short circuit current of the system is incorporated;

(f) access by unauthorized persons is prevented or prohibited and a notice to this effect posted at the entrance; and

(g) a notice is posted describing the procedure for first aid in case of electric shock.

9.22.10. Protection of portable, transportable and mobile machines

469. Transportable and mobile machines and their associated trailing cables operating above extra low voltage (normally <= 50V AC (rms) and <= 120V DC (ripple free)) should be protected by automatic earth leakage devices and by automatic earth continuity devices capable of cutting off the voltage in the event of a break in the earth conductor of the cable between the supply or control box and the machine.

470. In the case of earth leakage devices and related equipment, as defined in national laws, regulations or accepted standards, the following should be specified:

(a) the leakage current at which the equipment should be set to operate;

(b) the time to trip the circuit supplying the equipment; and

(c) in the case of any portable machine or equipment and its associated trailing cable operating at a voltage above extra low voltage, the value in milliamps at which an instantaneous-type earth leakage tripping device should be set to operate.

471. Portable electrical equipment and flexible cables should be protected by automatic continuity protection, capable of cutting off the voltage in the event of a break in the earth conductor of the cable between the supply or control box and the machine.

472. Any device limiting the fault current should have a time rating which is certified as being manufactured to an approved standard.

473. The inspection and testing intervals of equipment should be based on its use.

9.22.11. Miscellaneous safety procedures

474. Controls should be in place to prevent mobile equipment running over power conductors, nor should loads be dragged over power conductors, unless the conductors are properly bridged or otherwise protected.

475. Power circuits should be de-energized before work is done on such circuits unless hot-line tools are used. Suitable warning signs should be posted by the persons doing the work. Switches should be locked out or, where not possible, other measures taken to prevent the power circuits from being energized without the knowledge of the persons working on them. Such locks, signs or preventive devices should be removed only by the person who installed them or by authorized persons.

476. Electrically powered equipment should be de-energized before mechanical work is done on such equipment. Power switches should be locked out or, where not possible, other measures taken to prevent the equipment from being energized without the knowledge of the persons working on it. Suitable warning notices should be posted at the power switch and signed by the persons who are to do the work. Such locks, notices or preventive devices should be removed only by the persons who installed them or by authorized persons.

477. If equipment, other than a trolley locomotive, has to be moved or operated near energized high voltage power lines where the clearance is less than 3 m, the lines should be deenergized or other precautionary measures taken.

478. When a potentially dangerous condition is found, it should be corrected before equipment or wiring is energized.

479. Appropriate danger signs should be posted at all major electrical installations.

9.23. Transport and material handling

9.23.1. Mobile equipment

9.23.1.1 General provisions

480. This Section of the code is concerned with two types of equipment:

(a) all rubber-tyred or tracked, self-propelled mobile equipment used in or about an opencast mine for hauling, transporting, personnel carrying, lifting, hoisting, scraping and similar operations, and having a gross vehicle mass (GVM) in excess of 4,500 kg (heavy equipment); and

(b) vehicles whose GVM is below 4,500 kg, including jeeps, vans, four-wheel drive vehicles and the like (light vehicles).

481. Based on a risk assessment of the mobile equipment's characteristics and intended use, and in accordance with national laws, regulations and applicable standards, it should be equipped with appropriate falling object protective structures (FOPS), roll over protective structures (ROPS) and devices to protect an operator from falling or being propelled from the equipment.

482. All mobile equipment that transports people should be fitted with seatbelts for all occupants and these should be worn by all occupants when the vehicle is in transit.

483. Tests may be prescribed by the competent authority to assist safe operation of the equipment and devices concerned.

484. All self-propelled mobile equipment should be provided with adequate braking systems, capable of effectively stopping and holding the vehicle stationary when fully loaded, under any conditions of operation when driven correctly.

485. No mobile equipment should be left unattended unless:

(a) the controls are in the neutral position and the parking brakes fully applied;

(b) if it is a tracked and wheeled vehicle parked on a grade, that it is blocked or turned into a rib or bank;

(c) the movable parts of equipment such as dippers, buckets, scraper blades are secured or lowered to the ground when not in use; and

(d) the master switch of electrically powered mobile equipment is in the off position, all operating controls are in the neutral position, and the brakes are set or other equivalent precautions are taken against rolling.

486. When a vehicle is in motion between work areas, the movable parts of the equipment should be secured in the travel position.

487. Tipping body props or other devices should be provided and these should be capable of preventing a skip collapsing, and their mode of operation should be independent of the tipping mechanism.

488. The engine exhaust gases from mobile equipment operated by an internal combustion engine should be discharged at a point remote from the operator's position and from any air-conditioning intake where fitted.

489. All operators or drivers of mobile equipment should be trained, competent and authorized for the equipment they operate and the areas they operate it in.

9.23.1.2. Ergonomics

490. Particular attention should be given to cab design including:

(a) access to the cab – safe entry and exit for the operator and emergency egress;

(b) cab space – sufficient for all operators, especially when using seat adjustments;

(c) operator seating – appropriate for the vehicle with adjustment to accommodate different sized users;

(d) machine controls, such as location, layout, type, design and direction of movement of all control devices;

(e) location and design of emergency stops;

(f) location, design (fit-for-purpose) and quality of displayed information, including warnings;

(g) vision and visibility from the cab;

(h) protection against environmental hazards, including inclement weather, heat, cold, noise, vibration and airborne dust; and

(i) accessibility for routine service checks, regular maintenance and breakdown maintenance.

491. All motor vehicles should be equipped with effective and fit-for-purpose:

(a) headlights, tail lights and clearance lights;

(b) windscreen washers and wipers;

(c) audible warning systems, which should be sounded whenever the driver wishes to move the vehicle without having clear vision immediately in front and behind; and

(d) where needed: an effective and fit-for-purpose proximity detection system and reverse detection system.

9.23.1.3. Mobile equipment construction and use

492. The operator's cab of any vehicle used for rock haulage should be so constructed or reinforced as to resist damage by spillage.

493. The operator's cab should not be additionally equipped, altered or otherwise modified in a manner which impairs operating visibility or impairs the safety characteristics of the construction.

494. Cab windows should be of safety glass or equivalent, in good condition and should be kept clean. Access for cleaning should be safe and easy. Cabs of mobile equipment should be kept free of extraneous materials including equipment and fittings that might impede access to controls or the visibility of critical information either inside or outside the cab.

495. Fire extinguishers of an appropriate type and capacity should be installed on all mobile equipment, but should not intrude into the operator's workspace, block vision or cause obstruction, especially for emergency exiting of the machine.

496. A person should not operate, or be permitted to drive, mobile equipment at an opencast mine unless:

(a) they hold a current licence for that type of equipment issued by a competent authority; or

(b) they have satisfied competence criteria established at the mine to operate that type of equipment; or both.

497. No person should mount or enter any haulage machine being operated and capable of movement unless they have attracted the operator's attention prior to doing so.

498. Where loads are carried which project beyond the sides of vehicles, or by more than 2 m beyond the rear of the vehicles, there should be attached at the end of the projection:

(a) a warning light during the hours of darkness or in limited visibility; and

(b) a clearly visible warning flag of suitable size in daylight conditions.

499. Where overhead clearance is restricted, warning devices should be installed and the restricted area should be conspicuously marked.

500. Where the regular transport of persons is required, buses or other specially fitted vehicles should be used, equipped with seating and safe means of entry and exit.

501. The transport of persons should be prohibited in or on mobile equipment or parts of mobile equipment unless the equipment is properly designed for that purpose and is fitted with appropriate safety devices such as seatbelts for that purpose;

502. All ramps and dumping facilities should:

(a) be of substantial construction; and

(b) have suitable width to accommodate the equipment using the facilities.

503. Berms, bumper blocks, safety hooks or similar means should be provided and maintained as required to prevent overtravel and overturning at all tipping and dumping locations.

504. Chute loading installations should be so designed and installed that the persons operating them are not required to be in a hazardous position while at work. Any attempt to free a blockage in a chute should only be made by a competent person who fully understands the hazards involved and follows approved procedures.

505. All grizzlies, grates and similar stationary sizing devices should be securely mounted and anchored. Persons required to work on a grizzly while breaking rocks should be provided with and should wear a securely anchored safety belt.

506. Mobile equipment used in dumping and tipping operations should be provided with an automatic reverse signal alarm

which is audible above the surrounding noise level, or should have an observer to enable reversing to be carried out in safety.

9.23.2. Rail transport hazards

507. A set of plans should be prepared showing every part of a proposed rail system whose primary use will be for the transport of ore. A copy of the plans should be securely kept at the mine.

508. Railway operating procedures, including signals and signal codes and inspection and maintenance procedures to apply to all railway operations, should be prepared. No change should be made to these rules except in the case of an unforeseen occurrence, mishap or defect.

509. Every person employed on a railway operation on an opencast mine should be provided with a copy of the operating rules, signals and signal codes applicable to that mine. Before any person is employed as a train controller, locomotive driver, member of a train crew or driver of any rail track vehicle, they should be trained so that they are fully conversant with the relevant operating rules, signals and signal codes and are competent to discharge their duties and are authorized to work on the mine by the employer.

510. No person should be permitted to take or have charge of a locomotive on a mine railway unless they have demonstrated competence to do so (for example, by holding a locomotive driver's certificate issued by a competent authority). A person undergoing instruction may operate a locomotive under the supervision of a certified locomotive driver.

511. Road-beds, rails, joints, switches, frogs and other elements of every rail track, as well as bridges, culverts and other structures supporting it should be designed, installed and maintained in a safe manner consistent with the speed and type of haulage.

512. Locomotives, rolling stock, tracks and all other equipment used in the operation of a railway system should be maintained in a safe condition and should be subject to regular inspection at intervals to be laid down in operating rules.

513. Every train should be equipped with an effective braking system. Every locomotive, railcar, truck, wagon or other rail track vehicle should be provided with effective brakes which should be capable of being operated individually by hand and by the train braking system when forming part of a train.

514. There is no requirement to provide brakes for each vehicle if a single vehicle is attached to the end of a train, or if a single vehicle is towed by a self-propelled vehicle, the brakes of which are adequate for the task.

515. A train should not be left unattended unless brakes of sufficient strength to hold the whole train stationary have been applied. No railcar, truck, wagon or other rail track vehicle should be left detached from a train unless its brakes are applied or unless it is otherwise secured to prevent a runaway.

516. Positive-acting stop blocks, derail devices or other adequate means should be installed wherever necessary to protect persons from runaway or moving railroad equipment.

517. Every locomotive should be equipped with the following devices and systems, which should be maintained in good working order:

(a) effective headlights and rear lights;

(b) at least two braking systems (handbrakes and pneumatic or electric);

(c) a whistle or siren capable of giving clear and distinct warnings and signals;

(d) sanding devices;

(e) speedometers;

(f) adequate fire extinguishers; and

(g) first-aid equipment.

518. Only authorized persons should be permitted to ride on trains or locomotives and then only in positions of safety. In cases of accident or emergency, the employer may authorize the carriage of persons. Persons should not attempt to mount or dismount from moving equipment unless national legislation specifically permits it.

519. All loads should be securely attached to the rail vehicles.

520. Rocker-bottom and bottom-dump railcars should be equipped with locking devices.

521. Cars should not be coupled or uncoupled manually, unless the driver and the shunter are within clear view of each other, or they have some effective means of signalling to each other, or the cars are so designed and equipped as to minimize any hazard while performing this operation.

522. A driver who has not clearly recognized a signal given by the "brakeman" when the train is under the direction of the latter should assume it to be a stop signal.

523. No person should pass over, under or between cars unless the train is stationary and the driver has been informed and has clearly understood what is being done.

524. Railcars should not be left on side tracks unless ample clearance is provided for traffic on adjacent tracks. A locomotive on one track should not be used to move equipment on a different track unless a suitable system has been devised to do so safely. Where necessary, bumper blocks, buffers or the equivalent should be provided at track dead ends. Track guardrails, lead rails, frogs and guide rails should be protected

or blocked so as to prevent a person's foot from becoming wedged.

525. Public and permanent railroad crossings should be posted with warning signs or signals, or should be guarded when trains are passing and should be planked or otherwise filled in between the rails. If repairs are being carried out adjacent to rail tracks, special rules should be drawn up and implemented to provide for the safety of personnel and the safe movement of trains.

9.23.3. Aerial ropeways

526. The buckets of aerial ropeways should not be overloaded, and the feed should be regulated to prevent spillage.

527. Positive-action-type brakes – or devices which apply the brakes automatically in the event of a power failure – should be provided on all aerial ropeways.

528. Track cable connections should not obstruct the passage of carriage wheels.

529. All towers should be suitably protected from swaying buckets. Guard nets or other suitable protection should be provided where aerial ropeways pass over roadways, walkways or buildings. Persons should only be permitted to ride on aerial ropeways in accordance with the transport rules of the mine, which should forbid riding on loaded buckets. Whenever possible, operators should ascertain that all persons are clear before starting an aerial ropeway system and should give clear, audible warning of any impending start.

530. Persons other than maintenance personnel should not ride aerial ropeways unless the following features are provided:

(a) two independent brakes, each capable of holding the maximum load;

(b) direct communication between terminals;

(c) power drives with emergency power available in case of primary power failure; and

(d) buckets equipped with positive locks to prevent accidental tripping or dumping.

9.23.4. Conveyors

531. No conveyor should be operated unless it is provided with a system for stopping the belt from any point along its length.

532. Footbridges with handrails or rope bridges should be provided at intervals not exceeding 500 m in the case of combined excavator and belt transfer systems.

533. If the entire length of a conveyor is visible from the starting switch, the operator should visually check to make certain that all persons are clear of the conveyor before starting it. A positive audible or visual warning system should be installed and operated to warn persons that the conveyor is about to be started.

534. A conveyor belt should be provided with a device permitting any person, from any point along its length, to stop the belt and prevent it from being restarted.

535. Conveyors should not be used for the conveyance of people unless the design of the conveyor is certified by the competent authority and national laws permit and regulate the operation, inspection, maintenance and use of the conveyor for this purpose. No person should clean underneath a moving conveyor, nor any part of a moving conveyor, unless adequate protective guards are in place. Moving conveyors should not be crossed except at designated safe points designed for that purpose.

536. All head, tail and tension pulleys and sprockets of a conveyor should have their nip points adequately guarded (for example, for a distance of at least 1 m).

537. The guidance in the ILO code of practice *Safety and health in the use of machinery* (Geneva, 2013) (the "Machinery code") should be considered in this context.

9.23.5. Conveyor bridges, stacking conveyors and overburden spreaders

538. Structural members of conveyor bridges, overburden spreaders and excavating machines, together with all ladders and platforms thereon, should be cleaned off before the commencement of every shift.

539. All automatic control, tele-automatic and remote control systems should be provided with interlocking devices to interrupt the power supply in case of defective operation.

540. Conveyor bridges and overburden spreaders should be equipped with instruments for automatic continuous measurements of wind velocity and direction, interlocked with an emergency signalling system and a system of undercarriage control of overburden spreaders, as well as with control and measuring instruments, limit switches, signalling and intercommunication devices. In addition to automatic brakes, the bridge undercarriages should be equipped with intact handbrakes. No machine should be operated unless the abovementioned instruments, switches and devices are in good working order.

541. During repairs to a conveyor bridge, the simultaneous disassembly of the automatic brakes and the handbrakes should be prohibited.

542. Any counterweight should be effectively guarded. Conveyor lines on conveyor bridges and overburden spreaders

should be provided with servicing platforms guarded on both sides. No passageway along a conveyor should be less than 700 mm in width.

543. During inclement weather, thunderstorms, snowstorms, heavy rain or fog, when the visibility is less than 25 m, the passage of persons or work on a conveyor bridge should be suspended.

544. No conveyor bridge should be permitted to approach a structure or any mining and transport equipment to within a distance of less than 1 m or to operate in a position above other operating mining and transport equipment. Conveyor bridge railway tracks should not be used when they are under water.

545. Where persons walk or work under an elevated conveyor they should be guarded from falling objects.

546. When an overburden spreader of the walking or railway-walking type is in motion, no persons, nor transport vehicles, machines or other equipment should be permitted to pass under the dumping cantilever of a conveyor bridge.

547. The vertical distance between the end of a dumping cantilever of a conveyor bridge and the crest of the dump should not be less than 3 m; for overburden spreaders which move periodically and use a cantilever-type belt conveyor, this distance should not be less than 1.5 m.

548. If there are signs of a rock slide on a waste dump, a conveyor bridge should immediately be removed from the danger zone.

9.23.6. Stockpiles, bins and storage silos

549. The following precautions should be taken for all bunkers, silos, ore passes and storage piles:

(a) wherever practicable, special devices should be incorporated for breaking down material which has caked up, or for clearing other obstructions which have formed in the material;

(b) no person should be permitted to enter or work in such locations until all conveyors are locked out and other tipping activities have been stopped. A permit-to-work system should be devised for this specific purpose;

(c) persons should only enter under competent supervision;

(d) work involving entry into bunkers, silos or ore passes, which may constitute confined spaces, should be entrusted to experienced persons who have been specially instructed in the hazards involved;

(e) all persons entering should wear safety lanyards and a fall-arrest device attached to a secure fitting at the entrance;

(f) where appropriate, permanent ladders should be attached to the walls;

(g) the support structures of bins and silos should be protected against collision with moving equipment; and

(h) bins and silos should be regularly inspected by a competent person for hidden corrosion and wear.

550. When handling material which is liable to emit harmful or flammable gases, the atmosphere in the bunker or silo should be sampled and analysed before access is permitted and proper PPE should be issued and worn.

551. Tunnels below coal stockpiles and silos should be ventilated so as to maintain concentrations of firedamp or methane below 1 per cent.

552. When it is necessary for a tunnel to be closed at one end, an escape way of not less than 750 mm in diameter, or equivalent, should be provided, equipped with ladders as necessary,

which extends from the closed end of the tunnel to a safe location on the surface.

9.23.7. Mobile and travelling cranes

9.23.7.1. General provisions

553. The employer should ensure that all cranes, lift trucks and similar handling equipment in use at an opencast mine are constructed, operated and maintained in accordance with the relevant national standards and the manufacturer's specifications.

554. No modifications or major repairs should be carried out on a crane unless these are performed by a person competent in this field and the crane meets national standards and the manufacturer's specifications.

9.23.7.2. Safety precautions

555. The following precautions should be adopted in the operation of cranes and lifting devices:

(a) hitches and slings used to hoist materials should be suitable for the material being handled and should be in good condition;

(b) taglines should be attached to loads that may require steadying or guidance while suspended;

(c) persons should stay clear of suspended loads, should never be under a suspended load, and loads should not be lifted over people. Exclusion zones should be established around lifting operations;

(d) no material should be dropped from an overhead elevation unless the drop area has been cleared of personnel and either guarded or a suitable warning has been given;

(e) only trained and competent workers should be authorized to operate the crane and sling loads; and

(f) all cranes, lifting apparatus and rigging should be inspected, maintained and tested by competent persons and in accordance with national laws and approved standards.

556. Fork and other types of lift trucks should be operated with:

(a) the upright tilted back to secure the load;

(b) the load kept in the upgrade position when ascending or descending grades in excess of 8 per cent;

(c) with the exception of minor adjustments, the load should not be raised or lowered en route; and

(d) the load-engaging devices should be on the downgrade side when travelling unloaded on all grades.

9.24. Transportation of hazardous goods to and from site

557. The transport of hazardous goods (as defined in national laws and accepted standards) is normally controlled by an authority with jurisdiction for transport on the public road network. Transport is typically carried out through a system of licensing transport vehicles and licensed, competent operators.

558. The employer should take care to ensure that only appropriately licensed and qualified entities are used for the transport of hazardous goods to and from the mine site.

9.25. Traffic

9.25.1. Hazard description

559. Opencast mines are often characterized by a mixture of light vehicles (able to be registered for use on a public road) and heavy vehicles (for example, large haul trucks). In the absence of effective controls, the potential for light and heavy vehicle collisions is ever present. In addition, roads and supporting

infrastructure are made to "mine standards", which may be less than those required for the public road network.

560. Traffic hazards can be caused by interaction between vehicles, vehicles and other objects and personnel, or by loads falling off or from a vehicle. A particularly catastrophic but credible accident scenario is a collision between a heavy vehicle and a personnel transport or bus.

9.25.2. Risk management

561. The assessment of risk presented by the movement of traffic at a surface mine might include:

(a) the nature and needs of vehicles at the mine (for example, their turning circles);

(b) the condition and capability of roads and other facilities to service those needs (for example, grades, road width, road surface, and intersection design);

(c) the need for segregation, in space or time, of heavy and light vehicles, or personnel transport and other types of vehicles and pedestrian traffic;

(d) the fitness for purpose of traffic controls (for example, signage);

(e) the adequacy of dust control measures;

(f) the adequacy of water and, where relevant, ice control;

(g) the adequacy of procedures controlling traffic movement;

(h) the adequacy and use of operator and passenger protective devices (for example, seat belts);

(i) the effects of limited visibility envelopes of vehicles or machinery and the adequacy of vehicle visibility enhancements (for example, flashing lights, flags or colours);

(j) the need for and maintenance of no-go or exclusion zones around operating machinery; and

(k) the adequacy of inter-vehicle/machine communication.

9.25.3. Control strategies

9.25.3.1. Roads

562. All mine roads should be designed for, and of such width as will adequately contain the vehicles using them. They should be provided with a shoulder barrier (berm) of an effective size for the traffic using the road (for example, at least half the height of the largest wheel).

563. As far as practicable, light vehicles and, in particular, personnel transport should be segregated from heavy or haulage vehicles.

564. Haul roads should be of sufficient width to allow the safe operation of the largest vehicles that regularly use them and to allow access for emergency vehicles if required. For two-way traffic a width of at least 3.5 times the width of the largest vehicle should be considered; and for one-way traffic at least 1.5 times the width of the largest vehicle (width refers to the width of the useable running surface clear of guideposts, grader rills and safety berms). If the above control measures cannot be fully implemented, alternative risk reduction measures, such as traffic controls, should be applied.

565. Where appropriate, passing places, which should be clearly visible from both directions, should be provided on single-lane roads. The gradient and radius of any part of a road should be such that vehicles can negotiate the road in safety.

566. Such signs as may be necessary to control the speed and movement of all vehicles making use of roads should be put in place.

567. Mine roads should be adequately drained so as to control accumulations of standing water. Where required for surface maintenance or dust control, mine roads should be watered, but not to such an extent that safety is compromised. Roads subject to freezing conditions should be cleaned systematically of snow and ice and strewn with sand, gravel, slag or other suitable material.

568. Haul roads with steep gradients as determined by a risk assessment should have emergency escape or run-away roads, which should:

(a) be spaced throughout the length of the haul road;

(b) ensure that a runaway vehicle entering an emergency escape road can be safely brought to rest; and

(c) vehicles should not exceed the gradient specified by the manufacturer.

569. Haul road intersections should:

(a) be formed to be as square as possible;

(b) use centre berms to direct turning traffic;

(c) have a reduction of height of road berms on the approach to allow for improved visibility;

(d) have appropriate signage, such as:

(i) stop or give-way signs controlling minor roads;

(ii) keep left or keep right signs on centre berms, as appropriate;

(iii) side road and intersection warning signs; and

(iv) strategic placement of chevron warning signs.

570. The design of roads should avoid sharp bends. Should sharp bends exist, appropriate control measures should be considered.

9.25.3.2. Traffic rules

571. The operating speed of vehicles should be consistent with conditions of roadways, grades, clearances, visibility, traffic and the type of vehicle. Operators should maintain full control of vehicles while in motion. Haulage vehicles should be operated under power control at all times. Maximum permissible vehicle speeds should be posted.

572. Haulage vehicles should remain a safe distance apart (for example, 50 m on haul roads and 30 m near loading and tipping points) and other vehicles should remain sufficiently separated to allow for potential spillage from haulage vehicles.

573. Haulage vehicles should travel in single file (not overtake) unless another vehicle is stationary (for example, broken down or temporarily parked). Other vehicles should not overtake unless there is positive communication with the other vehicle (not just traffic indicators) and it is safe to do so.

574. As far as practicable, all vehicles should be fitted with two-way radios to allow communication between them and operating face machinery. The use of mobile phones, including via hands-free appliances, should be prohibited while vehicles are in motion.

575. All vehicles should carry fire extinguishers of a suitable rating and compliant with accepted standards. All vehicles should be fitted with three-point seat belts, which should be worn.

576. All vehicles should utilize flags, flashing lights and distinctive marking to aid visibility, as appropriate. Visitors' vehicles, or others not so equipped, should be escorted by an equipped vehicle. Vehicles should not be left unattended while the engine is running.

577. When haul roads are discontinued, the traffic plans should be altered and shared with the workers.

9.25.3.3. Traffic signs

578. Traffic signs should, as far as practicable, be identical to those used in the public road network beyond the mine site. Traffic signs should be installed at critical points, for example:

(a) intersections;

(b) where speed limits change;

(c) at major changes in road grades;

(d) changes in normal traffic flow; and

(e) to indicate particular road hazards, as needed.

579. Traffic signs should be part of regular mine inspections and repaired or replaced as required.

9.25.3.4. Parking areas

580. Parking areas should be designated and signposted with provision for inherently stable parking (for example, humps or spoon or V drains). Parking areas should also include:

(a) protection for pedestrians (for example, separate walkways, one-way traffic flow, walkways not crossing traffic routes);

(b) protected maintenance bays, as appropriate;

(c) adequate safe separation for heavy vehicles (for example, at least 5 m);

(d) separate light and heavy vehicle parking; and

(e) adequate lighting.

9.25.3.5. Clearance distances

581. Adequate safe distances should be maintained between vehicles and operating machinery, especially in a face area, with the use of electronic proximity warning systems being desirable.

582. Before a vehicle enters the operating envelope of machinery there should be positive communication between the driver and the machinery operator.

583. Vehicles should remain a safe distance from high walls.

9.26. Multiple-people carriers

9.26.1. Hazard description

584. The size of operations and their relative remoteness often means that opencast mines need to transport large numbers of people at the same time in a single conveyance. This includes work crews being transported to the working section of an opencast mine, the transport of workers to and from a mine site from towns or mine camps and, in the case of fly-in fly-out operations, by aircraft.

585. These arrangements present a very significant exposure to risk. The probability of a major accident involving such forms of transport may be relatively low, but the potential consequences (multiple fatalities) could be catastrophic.

9.26.2. Assessment of risk

586. The risk assessment of multiple-people off-site transport might consider such factors as:

(a) who is to be transported and in what numbers (as a measure of potential exposure);

(b) the purpose of the transport;

(c) the mode of transport;

(d) the safety design and characteristics of the transport;

(e) the optimal maintenance and timely replacement of transport vehicles and planes;

(f) the credentials and reliability of transport providers; and

(g) the level of competence of the transport operator (driver, pilot).

9.26.3. Control strategies

587. Control strategies for the transport of people might include:

(a) reducing exposure by transporting fewer people, or using multiple vehicles (for example, conducting a number of flights to transport key personnel, or using more and smaller buses);

(b) considering whether the transport is absolutely necessary (in other words, could the same purpose be achieved by another means (for example, could workers be accommodated closer to the site));

(c) considering the safest mode of transport available (for example, is the time saved on a notoriously dangerous flight route justified, compared with road transport or other safer means);

(d) fitting of all road transport with seat belts for drivers and passengers and ensuring their use;

(e) considering the age and ensuring the mechanical and design integrity of the transport (fitness-for-purpose);

(f) using only reputable and licensed transport providers, including through checking their credentials and past performance;

(g) considering the use of in-house transport so that greater control can be exercised;

(h) ensuring that the transport operator (driver, pilot) has an acceptable level of competence (qualifications, skill and experience), including by checking licences and past performance;

(i) regular inspection and maintenance of critical controls, for example, braking and steering systems; and

(j) considering suspending production and/or traffic when there could be contact with multiple-people carriers.

9.27. Explosives

9.27.1. General provisions

588. No person should handle or have access to explosives or detonators at an opencast mine unless they are approved for that activity by the competent authority. "Handling explosives" includes the activities of conveying, manufacturing, processing, possessing, using, preparing for use, treating, dispensing, storing, packing, selling, supplying, rendering harmless, abandoning, destroying and disposing of explosives.

589. Only explosives and detonators approved by the competent authority and provided by, or with the knowledge of, the employer in charge of the mine should be used at an opencast mine. National laws should define the term "explosive" and specify the conditions governing its manufacture, transport and use.

9.27.2. Storage of explosives

590. A magazine built at a mine where explosives are to be stored should be constructed in accordance with the requirements of, and should be licensed by, the competent authority. Detonators and detonating accessories should not be stored in the same magazine as other explosives unless kept in a separate approved compartment.

591. Every main magazine should be under the charge of a competent person assigned by the employer for the purpose who should be responsible for access to the magazine

and the safe storage and issue of the explosives. The employer should ensure that a durable record is kept, which should show the quantities of explosives on hand and the quantities of explosives received or issued, as well as the dates and times at which they were received or issued, and to whom. With the exception of explosives, articles likely to cause a fire or explosion should not be taken into or permitted to remain in such a magazine.

592. Persons should not smoke or permit an open flame to be within a specified distance (for example, 6 m) of any place where explosives are stored, transported or used. Every magazine should be kept clean, dry and adequately ventilated and the roof and walls maintained in good and safe condition.

593. The area surrounding a magazine should be kept free of dry grass, bush, rubbish and other flammable material for an appropriate distance or as may be prescribed in national legislation and, where practicable, enclosed by a fence.

594. Explosives which have deteriorated should be isolated and destroyed in an approved manner in accordance with the manufacturer's instructions.

595. Where operations at a mine or part of a mine are to cease or be suspended, all explosives should be removed to a safe place or destroyed in an approved manner. The competent authority should, as soon as practicable, be informed of such removal or destruction.

9.27.3. Transport of explosives

596. The employer should prepare procedures to regulate the transport of all explosives and detonators at the mine. Vehicles used for the transport of explosives should comply with the following requirements:

(a) they should have substantially constructed bodies, no sparking metal exposed in the cargo space, and should be equipped with suitable sides and tailgates;

(b) they should be equipped with suitable fire extinguishers, wheel chocks and, when powered by an internal combustion engine, a battery isolating switch;

(c) when transporting explosives or detonators, they should be posted with proper warning signs;

(d) if they are parked while containing explosives or detonators, the brakes should be set, the ignition switched off, the vehicle blocked securely against movement and never left unattended;

(e) when required to be taken to a garage or repair shop for any purpose, they should be emptied and cleaned out; and

(f) their trailers, if used, should be fitted with efficient brakes and coupled to the towing vehicle by a properly designed rigid tow bar and safety chain couplers.

597. Explosives should be transported in separate vehicles from detonators, unless both materials are housed in separate and properly constructed and locked containers. National laws should state the maximum quantities of explosives and detonators which may be transported.

598. If explosives or detonators are hauled by trolley locomotive, they should be placed in covered, electrically insulated cars.

599. Explosives or detonators should not be transported on locomotives. Only the necessary attendants should be allowed to ride on or in vehicles containing explosives or detonators. Explosives or detonators should not be transported on or with vehicles transporting workers.

600. Explosives and blasting agents should be correctly and stably loaded, and transported without undue delay, over routes

and at times that expose the minimum number of persons. Other materials or supplies should not be placed in or on the cargo space of a conveyance containing explosives, detonating cord or detonators. Safety fuses contained in properly secured non-sparking containers used expressly for the transport of such fuses may be placed in the conveyance.

601. Substantial non-conductive containers should be used to carry explosives to blasting sites. Substantial non-conductive containers with tight-fitting covers should be used to transport or carry capped fuses and electric detonators to blasting sites.

602. Vehicles containing detonators or explosives, other than blasting agents, should not be left unattended except in blasting areas during loading or charging operations.

603. Separate containers for explosives, detonators, blasting agents, fuses and detonating accessories should be provided and used where these are carried manually.

9.28. Shotfiring

9.28.1. General provisions

604. National laws and site procedures should specify the extent of the danger zone surrounding surface blasting operations, procedures to protect persons and property at risk of being affected by shock waves (vibration), flying fragments, dust and fumes from blasting operations.

605. No person may charge explosives unless authorized by the employer to do so, and any person thus authorized should be under the supervision of the shotfirer. Trainee shotfirers may be authorized by the employer to fire shots under the supervision of and in the immediate presence of a competent person.

606. The following precautions should be observed in the preparation for blasting:

(a) explosives should be kept separate from detonators until charging is started;

(b) primers should be made up immediately prior to use, and as close to the blasting area as conditions allow;

(c) only wooden or other non-sparking implements should be used to open cases of explosives and to punch holes in an explosive cartridge; and

(d) blasting caps should be crimped to fuses only with implements designed for that specific purpose.

607. A charge of explosive should not be fired in an opencast mine unless and until:

(a) the person in charge of the blast has cleared all persons from the danger zone, and has posted sentries at all points of entry to prevent inadvertent access (for example, and depending on the circumstances, an exclusion zone of 500 m may be established);

(b) proper warning has been given:

(i) in all adjacent areas from which a person might approach the danger zone; and

(ii) over all radio channels and once a warning is given, radio silence should be imposed;

(c) all persons who are in places where they might be injured by the blasting have been warned; and

(d) all such persons have taken adequate shelter or left the area.

608. All overhead and cable power lines located within the danger zone during blasting operations should be de-energized during the blast, and should be inspected before being re-energized.

609. Where blasting at an opencast mining operation could constitute a public nuisance or danger, the competent authority

may require the installation and operation of an audible warning device or other form of notification.

610. Where surplus or deteriorated explosives have to be disposed of, the advice of the manufacturer should be sought, and the destruction carried out in accordance with an agreed and developed procedure laid down by the employer.

611. When blasting operations are to be carried out in hot strata, the employer should ensure that a working procedure has been devised to deal with the resulting specific hazards.

9.28.2. Misfires

612. The employer in charge of a mine where shotfiring is practised should draw up a scheme specifying the procedure to be followed in the event of a misfire. When a misfire is known or suspected to have occurred, no work should be done at the site until the shotfirer or another experienced person has inspected the site at which the misfire occurred and taken such action as may be necessary to ensure that further work may be safely continued. No person should approach a misfired hole:

(a) when a safety fuse has been used, until at least 30 minutes have elapsed since the time of lighting the fuse; and

(b) when electrical firing has been used, until the shotfiring lines have been disconnected from the source of electric power and been short-circuited, and then at least 15 minutes after that have elapsed.

613. After the appropriate time interval, the shotfirer should inspect, or where they cannot do so, instruct another competent person to inspect the bench or face and take such action as may be necessary to ensure that further work may be safely continued (for example, misshole refiring or washing the misshole out).

614. A record of the inspection and of the action taken should be made, in a book kept at the mine for the purpose, at the end of the shift by the person making the inspection.

615. It is also common practice for the competent authorities to require the reporting of instances of misfires.

9.28.3. Electrical firing

616. Electric detonators of different types should not be used in the same round. All necessary testers, exploders, switches, fuses, electrical conductors and other necessary apparatus should be suitable for the conditions under which they are to be used, and should be provided by the employer.

617. No meter or device for the purpose of testing the resistance or continuity of circuits intended for electrical firing should be used, unless it is of a type which has been approved. Except when being tested with an approved instrument:

(a) electric detonators should have a shunt fitted until they are being connected to the blasting line or wired into a blasting round;

(b) wired rounds should be kept shunted until they are being connected to the blasting line; and

(c) blasting lines should be kept shunted until immediately before blasting.

618. When blasting electrically in opencast mine operations, an instrument specifically designed and approved for testing blasting circuits should be used to test the:

(a) continuity of each detonator in the borehole, prior to the addition of stemming;

(b) resistance of individual series or the resistance of multiple balanced series to be connected in parallel, prior to their connection to the blasting line;

(c) continuity of blasting lines, prior to the connection of electric detonator series; and

(d) total blasting circuit resistance, prior to connection to the power source.

619. Where firing is carried out by means of electric power circuits, the:

(a) voltage and current should be adequate for the number of detonators and type of circuit, and the voltage used should not exceed medium voltage;

(b) shotfiring cables should be isolated from the source of power by a double throw switch, by means of which the cables are short-circuited and earthed when disconnected from the source of power;

(c) isolating switch should be housed in a box with a locked door; and

(d) shotfiring leads are connected to the firing cables through two-pin plugs fitted to appropriate bases connected to the firing cables.

620. Immediately after firing any charge, the shotfirer should disconnect the firing cable from the source of power and lock the box. The key to the door of the isolating switch box should not, under any circumstances, pass from the personal custody of the shotfirer on duty.

621. An exploder may be used for firing:

(a) single electric detonators; or

(b) electric detonators wired in series.

622. An exploder should not be used for firing electric detonators wired in a circuit which combines series and parallel wiring unless authorized by the employer. The exploder should

have adequate capacity for the number of detonators to be fired in the circuit.

623. The exploder should be in the charge of the shotfirer on duty and should be fitted with a handle, key, or other device, the removal of which will render the exploder inoperative. It should be the duty of the shotfirer to ensure that the exploder is inoperative when not in use for firing and the handle, key, or other device should remain in their personal custody while they are on duty.

624. A hole being charged with ammonium nitrate blasting agent should be loaded so as to obtain a continuous explosive line. For charging purposes where other means are not practicable, ammonium nitrate blasting agent may be poured into a hole.

625. Pneumatic loading of ammonium nitrate blasting agent should not be used unless adequate steps have been taken to eliminate the hazard of static electricity including the grounding and bonding of the conductive parts of the pneumatic loading equipment. The loader and its associated equipment, when earthed, should give a total resistance to earth of not more than 1 megohm.

626. Water lines, compressed air lines, wire-covered hoses, rails or permanent electrical earthing systems should not be used as a means of earthing.

627. Permanent blasting cables should be properly supported, insulated and maintained in good repair by a qualified mine electrician.

628. Conductors for blasting lines should:

(a) be readily identifiable as being for blasting use;

(b) be waterproofed;

(c) consist of two insulated conductors; and

(d) be kept as far as possible from any power or lighting cable, and kept out of contact with any pipes, rails or other conductive materials.

629. Detonators should not be used in the presence of radio transmitters or other radio frequency fields except in accordance with standard distances provided for in national regulations, unless the detonators are coupled to transformers which are specifically designed to prevent induction of electrical current sufficient to activate the detonator.

630. No attempt should be made to charge, connect or fire a blast electrically if there is any sign of thunderstorm activity. If the presence of static electricity or stray currents is detected during charging up with electric detonators, charging should be stopped immediately and only resumed after the condition has been remedied.

9.29. Drilling

9.29.1. General safety precautions

631. Before the commencement of drilling operations, the area should be carefully inspected for misfires, sockets and other hazards. After a hole has been drilled, it should be closed off by a plug. Safe work procedures should be prepared and followed for each type of drilling employed.

9.29.2. Drilling rigs

632. Drilling rigs should be operated on a level surface. If working on a bench, the rig should be located a safe distance (for example, not less than 3 m) from the bench crest, especially when drilling the nearest hole to the crest – in this case, the operator should not have their back to the crest. While in operation, a drilling rig should be so arranged that its longitudinal axis is perpendicular to the bench crest.

633. When a drill is being moved from one drilling area to another, drill steel, tools and all other parts of the machine should be secured, and the mast placed in a safe position. If a drill helper assists the drill operator during the movement of a drill to a new position, the helper should be in sight of, or in communication with, the operator at all times.

634. No person should be on a rig mast while the drill bit is operating. When the rig mast is being raised or lowered, persons should not be permitted to remain in front of or behind a drilling rig.

635. Tools or other objects which might cause injury to personnel should not be left loose on the mast or drill platform.

636. With rotary drilling rigs for which the assembly and dismantling of the drilling set and the cleaning of the mouth of the hole are not mechanized, the augers should be enclosed and they should be interlocked with the electric power supply to the rotary driving motor.

637. Where there is an identified risk of inhalable or respirable dust, drill rigs with a properly designed and maintained dust suppression and collection system should be used.

9.30. Excavation and loading

9.30.1. Excavation

638. The employer in charge of the mine should ensure that excavation and loading rules, detailing the procedures to be followed during such operations, are prepared and followed.

639. Electrically powered equipment should be disconnected before mechanical work is done on such equipment. Power switches should be locked out or other measures taken to prevent the equipment being connected again without the knowledge of the persons working on it. Such locks or protective devices

should not be removed except by the person who installed them or by an authorized person.

640. In case of an unforeseen interruption of the electric power supply, the operator should immediately return all starters and control levers to the "stop" or "zero" positions.

641. The employer should ensure that technical instructions are prepared for each type of machine in operation. In addition to technical details relating to the machine, the information to be contained on this sheet should include the permissible dimensions of working places, bench heights, stability angles and distances that should be maintained by mining machines and transport equipment from working faces, dumps and tipping points. This information sheet should be posted in the proximity of the operator's position on the machine concerned.

642. The cabins of all excavating machines should be so equipped that the operator can always keep that part of the working face adjacent to the machine in sight. All sites where excavating machines are operating should be equipped with a means of communication with the machine operator. Cabins should be positively ventilated, and air-conditioned in significantly hot or cold areas.

643. Rail-mounted excavators should not be set in operation unless the tracks have been examined and pronounced safe.

644. Cab windows should be of safety glass or equivalent, in good condition, and should be kept clean.

645. No unauthorized person should be allowed in the cabin or on the external platforms of an operating excavator. No person should mount or enter any excavator being operated and capable of movement without first attracting the operator's attention.

9.30.2. Single-bucket excavators

646. When moving an excavator, the driven axle should always be positioned either at the downhill end or at the rear if the machine is level. The bucket should be empty and maintained at a height of not more than 1 m above the ground. The boom should face in the direction of motion.

647. In the case of a walking excavator, the bucket should be empty and the boom should face backwards, opposite to the direction of movement. When moving on a gradient, all possible precautions should be taken against sliding of an excavator.

648. Where it is necessary to move an excavator using the aid of an assistant, the assistant should use approved signals and should be within sight of the operator at all times.

649. Excavators should stand on a firm and level base, with a gradient not exceeding the permissible gradient specified in the technical instruction sheet. In all cases, the distance from the flank of a bench or dump or any transport vehicle to the counterweight of an excavator should not be less than 1 m, and the cabin of the machine during operation should be placed in such a way that danger to the operator is minimized.

650. The employer should ensure that a special code of signals is established for the operators of excavators to be applied to the loading operation. This code of signals should be posted on the excavator in a prominent position.

651. During the loading of railcars by excavators and the unloading of cars at dumping positions, the train team should follow the signals given by the excavator operator's assistant. These signals should correspond to those envisaged in the railway operating rules.

652. A free passage should be maintained at all times to enable an excavator to be speedily removed from a mining face.

An excavator in operation should be stopped and removed immediately to a safe place when any dangerous conditions are detected, and particularly when there is a likelihood of rock falls from the face or when misfires have been located in the working area.

653. In cases where stripping and loading operations are performed with the aid of a dragline excavator, safety rules should be established by the employer and brought to the attention of all concerned. In particular, safe distances between machines should be established when two or more types of machines are working together.

9.30.3. Multi-bucket and rotary excavating machines

654. The technical instruction sheet should specify the permissible limits for gradients and radii of curvature for railway tracks and roads used by tracked and wheeled excavating machines and walking excavators.

655. Track gauges and other devices used for making observations on variations in track width and gradients should be checked at least once a month. The results of the checks should be recorded in the book kept at the mine for that purpose. No excavating machine should be operated if the gauges and devices for variations in track width and gradient are missing or defective.

656. Rotary excavating machines with extractable booms which cannot be retracted should be fitted with automatic devices to ensure that the specified rates of movement and angles of turn of the rotary boom are not exceeded.

657. Multi-bucket excavating machines should be fitted with devices for preventing the bucket frame, rotary boom and conveyor from lifting, lowering or turning through angles greater than those provided for in the machine design.

658. The operator's cabin of an excavating machine should be equipped with an alarm signalling board and with instruments for controlling the:

(a) rate of motion and turning angle of the rotary boom;

(b) rate of motion of the excavating machine; and

(c) voltage and power load at the lead-in of the machine.

659. During operation of a multi-bucket excavating machine, no person should be allowed adjacent to or between the cars being loaded, below loading and unloading points and conveyors or reloading devices, or under the chassis frame of the excavating machine.

660. Before starting a new cut with a multi-bucket excavating machine, the appropriate supervisor should inspect the face and take any necessary steps for the removal of foreign bodies such as large tree roots, pieces of timber, metal objects and the like along the entire front of operation of the machine and to the full width of cut, taking into account the angle of response.

661. A multi-bucket machine with bottom digging should not be operated where there is a possibility of rocks sliding on the face, and where the required stability of the slope and that of the working surface cannot be ensured.

662. In a combined operation involving a rotary excavator with conveyors and overburden spreaders, or a multi-bucket excavating machine which loads spoil on to a conveyor, the controls of the excavators/conveyors/spreaders should be interlocked.

663. In order to carry out repair and adjustment work, measures should be provided for manual control of each separate machine.

9.30.4. Scrapers and bulldozers

664. Drag cable scrapers should not be used on bench slopes having an inclination in excess of 5 degrees. No scraper plant should be started up unless a prior warning signal has been given; during the operation of a scraper, no person should attempt to make repairs or adjustments, to stand near the rope, or to guide the rope by hand.

665. While operating on a bench, self-propelled and tractor-hauled scrapers should not approach within 2 m of the bench crest. No scraper should be permitted to move backwards downhill when unloading.

666. Scrapers hauled by wheeled tractors should not be permitted to negotiate access roads having a gradient greater than:

(a) 15 degrees in the case of a loaded machine; or

(b) 25 degrees in the case of an empty machine.

667. When operating a tractor-type bulldozer, it should be prohibited to:

(a) leave a machine with the engine running and the blade lifted;

(b) stand on the blade frame or on the blade;

(c) operate a machine that is not fitted with an interlocking device to prevent the engine from starting when it is in gear; or

(d) operate a machine that is not fitted with a device which requires the engine to be started from within the cab.

668. All repairs, lubrication or adjustments to a bulldozer should be performed with the machine on level ground, the engine switched off and the blade or ripper lowered to the ground. Where, because of failure or defect, a bulldozer is stopped on a slope, steps should be taken to block the machine

in position so as to avoid any downhill movement before repairs are attempted.

669. Should it be necessary to carry out an inspection of the underside of a bulldozer blade or ripper, the blade or ripper should be lowered on to firm supports and the engine stopped. No person should be permitted to go under a lifted blade except if it is firmly chocked up and permission has been given by the competent person.

670. On every face or bench where a bulldozer may be called upon to operate, written instructions should be prepared, based on the conditions at each working place, and stating clearly the distance from the edge which no bulldozer may cross.

671. Bulldozers should not be permitted to operate on slopes where the inclination measured along the steepest plane exceeds 25 degrees or on any slope which has a dangerous cross inclination.

9.30.5. Loading and dumping

672. The employer should ensure that all equipment and vehicles in use for these operations are of an approved type and conform with such specifications and requirements for safety as may have been laid down in national laws.

673. The following precautions should be considered during loading operations:

(a) a driver of any truck should not enter or leave their cab;

(b) the loaded bucket of any shovel or loader should not be traversed over the driver's cab of a truck or other motor vehicle;

(c) any person or equipment entering the loading area, such as bulldozers and dump trucks, must first have positive two-way communication with the loading machine operator. All persons should keep clear of the area between the loading unit and the

mine face, and the area traversed by the loading bucket during loading operations;

(d) all rocks that are too large to be handled safely should be broken before loading;

(e) transport equipment should be loaded in a manner to minimize spillage during haulage; and

(f) proximity detection or location devices should be used.

674. The following precautions should be adopted during dumping operations:

(a) where there is a possibility that the ground at a dumping place may fail to support the weight of a vehicle, loads should be dumped back from the edge of the bank;

(b) a vehicle should not be permitted to dump a load over a bank or into a bin, unless there is an effective backstop provided;

(c) when dumping is carried out, whether by day or by night, marker guides or other effective signs should be placed to indicate to the driver the limit of the safe approach to the tipping area;

(d) when dumping is carried out during the hours of darkness, the area should be illuminated by lighting units so placed as to give effective illumination to the working area and to the edge of the dump area;

(e) adequate artificial lighting should be provided at all points where poor visibility or work during the hours of darkness may present a hazard; and

(f) there should be no reflections, dazzle or glare which cause decreased visibility.

10. General controls

675. There are a number of controls which have an impact across a range of hazards. For example, the spatial information provided through surveying is used for a number of purposes. If that information is inaccurate, then the impact can be seen in several areas. Another example is inadequate training arrangements which can have a broad impact across an organization.

676. Great attention should be paid to these controls, as the failure of one can have an impact across a number of safety and health management arrangements.

10.1. Surveyors and plans

10.1.1. Competent surveyor

677. No opencast mine should be worked unless there is a competent mine surveyor. No person should be assigned as the mine surveyor unless they are considered competent in accordance with national laws.

10.1.2. Responsibilities of the mine surveyor

678. The mine surveyor should be required to:

(a) prepare or supervise the preparation of all plans, drawings and sections of the mine which are required by national laws;

(b) establish the accuracy of any plans, drawings or sections which have not been prepared by the mine surveyor; and

(c) ensure that all working papers, calculations or other notes which were necessarily used in the preparation of any plans, drawings and sections are signed, dated, properly filed and preserved.

10.1.3. Plans: General

679. Every mine should keep accurate plans showing particulars of all the workings, together with such other information as may be specified by national laws. All plans should be kept up to date periodically, as often as required for their purpose and as may be specified by national laws.

10.1.4. Plans: Requirements

680. At every mine there should be:

(a) a general plan of the mine showing: existing workings of the mine, including disused workings; proposed workings of the mine; any other disused workings that are attached, or in close proximity, to the mine; and the location or best estimated location of any adjacent mine workings or geological structures which may impact on the mine; and

(b) an emergency plan for the mine showing such things as the position of all telephones and other communication equipment, first-aid stations, and firefighting and rescue devices. The emergency plan should always be available for the information of workers and to external emergency services.

10.1.5. Faulty plans

681. The competent authority should be empowered to direct the employer to have the mine surveyed and new plans prepared if plans are found to be inaccurate or deficient.

10.1.6. Abandonment plans

682. No mine or part of a mine should be abandoned until the mine plans, including an accurate survey of all areas where mining has been conducted, have been brought up to date. Abandonment plans should contain all the information specified in national laws, together with any other information not

so specified which may affect the safety of the surrounding area, including neighbouring mine workings; such plans should be endorsed with a certificate from the mine surveyor attesting to their accuracy and any limitations thereon.

683. Abandonment plans should be submitted to the competent authority, which should store them safely and should keep a proper register of stored plans; they should be made available to all persons having a proper interest in them.

10.2. Mine registration and record-keeping

10.2.1. Commencement and cessation of mining operations

684. Any opencast mine should be registered with the competent authority in a manner consistent with national laws. Notification should be made to the competent authority along with plans and details of the mining scheme and equipment before the:

(a) commencement of any mining operation;

(b) the reopening of an abandoned or closed mine; and

(c) the proposed closure of a mine, indicating whether the closure is temporary or permanent.

685. Where a change occurs in the ownership or the name of a mine, or the identity of the mine operator, the latter should, as soon as practicable, notify the competent authority of the change.

10.3. Records and returns

686. All records, reports, plans or other documents required by national laws on matters of safety and health should be kept in a secure manner at the mine and should be available for inspection by the competent authority and the workers' representatives.

687. 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. These should be made available to the workers' representatives.

10.4. Mine design and methods

10.4.1. Design requirements

688. Where an opencast mine excavation is planned to exceed a significant depth (for example, 10 m), the operator should, prior to the commencement of excavation, prepare:

(a) a mine design; and

(b) an operating manual.

689. The mine design should include:

(a) maps and, where available, recent aerial photographs, showing the location and physical features of the mine area, including local drainage systems;

(b) drawings showing:

(i) the contours of the ground before any site preparation;

(ii) structural geology in the region of the mine;

(iii) a plan of the mine illustrating the projected five-year plan;

(iv) typical cross-section through the walls;

(v) the location of any diversionary drainage systems; and

(vi) the results of any tests, studies and investigations to determine:

(1) geotechnical properties of the rock and soil in the vicinity of the walls; and

(2) groundwater conditions in the vicinity of the mine;

(c) the design, position, nature of construction and stability analysis of any support structures to be incorporated in the walls;

(d) a stability analysis including an outline of any design assumptions that were made; and

(e) details of any testing and instrumentation which may be required to monitor wall or strata movement and groundwater conditions in the region of the mine to verify the design assumptions.

690. The operating manual should include:

(a) specifications for the configuration of the final mine walls, including toe and crest positions, planned face slopes, average overall wall slopes, bench widths, bench intervals and any berm construction;

(b) the method and rate of excavation to the final walls;

(c) details of any blasting procedure to maintain control of the pit wall;

(d) specifications for drainage and dewatering systems; and

(e) details including location, method and frequency of reading and of maintenance of any instrumentation required to monitor wall and strata movement or groundwater conditions in the region of the mine.

691. Where an amendment to any design is proposed, the employer in charge of the mine should prepare a report showing:

(a) the extent of the land to be disturbed by any additional excavation;

(b) the new design height of any wall;

(c) details of any additional site preparation and excavation, including any blasting procedures that may be required; and

(d) an analysis of the safety aspects of the intended design to include the results of:

(i) geotechnical studies, including drill-hole logs, tests and groundwater measurements; and

(ii) stability studies to assess any effects of the amendment on the safety and ground stability of the walls.

10.4.2. Stripping of overburden

692. Vegetation, such as bushes and trees, should be removed from the overburden before stripping. Foundations of buildings should be similarly removed when stripping reaches their level.

693. When the overburden consists of unconsolidated or blasted material:

(a) excavation by undercutting should not be used;

(b) if mechanical equipment is not used, no place should be worked unless the material is at a stable angle; and

(c) if mechanical equipment is used, no working face should have a vertical height greater than the maximum height to which the excavation equipment in use can reach.

694. All rock, stone or other material from the stripping of overburden should be dumped, tipped or otherwise disposed of safely.

695. Where mining is to be carried out in regions of heavy snowfall or heavy rainfall, particularly in areas liable to flash flooding, lightning strike or where monsoon conditions are prevalent, or in active seismic areas where earthquakes and landslides may be expected, or in areas of volcanic activity, special protective procedures should be developed and copies of these procedures kept at the mine. These protective procedures should be in accordance with the mine emergency plan.

10.4.3. Mining methods

696. Mining methods include but are not limited to: truck and shovel, strip, quarrying, and rock sawing, among others. A risk assessment should be performed to determine the specific control measures required to manage the people, equipment and work environments that are involved.

697. Mining methods should be used that will maintain wall, bank and slope stability in places where persons work or travel in performing their assigned tasks. When benching is necessary, the width and height should be based on the type of equipment used for cleaning of benches or for scaling of walls, banks and slopes, and the safety of any persons or vehicles working or travelling thereon.

698. Ground conditions that create a hazard to persons should be mitigated or supported before other work or travel is permitted in the affected area.

699. Until corrective work is completed, the area should be posted with a warning against entry and, when left unattended, a barrier should be installed to impede unauthorized entry. Trimming, scaling and support should be carried out from a safe location.

700. The vertical height of a bench face being worked should not exceed a safe height, for example, 8 m if is to be worked manually, or 20 m if it is to be loaded mechanically. This provision should not prevent a mine from being worked with two or more benches having a face height not exceeding 8 m and 20 m correspondingly.

701. Persons should not be permitted to work or travel between machinery or equipment and the high wall or bank where the machinery or equipment may hinder escape from falls or slides from the high wall or bank. No person should be

deployed in a determined exclusion zone of mechanical equipment unless that equipment is effectively immobilized.

702. In cases where an opencast mine is being worked in the vicinity of any underground workings, no face of the opencast mine should be advanced over the underground workings if danger could be occasioned to persons in the underground workings or in the opencast mine unless the competent authority has been informed beforehand and approval has been obtained for the method of working to be implemented.

703. Blasting should not be performed in underground workings that lie within 30 m vertically below the bottom or 60 m horizontally from the wall of any opencast mine in which work is being carried out, unless consultation has taken place between the managements of both enterprises to devise and implement suitable precautionary measures to ensure safety.

704. No person should work or climb on top of any surge stockpile in active use to which broken rock is fed from above and from which the rock is withdrawn unless all the following provisions are complied with:

(a) they have been authorized to do so by the employer;

(b) the feed to and from the stockpile has been stopped and locked out;

(c) it has been established that the chute below is not in the discharging position;

(d) they are wearing a safety belt attached to a rope of correct length, securely fixed to an anchorage above them; and

(e) they are assisted by another person stationed at a safe vantage point above them.

705. A tunnel under a surge stockpile of broken rock or other unconsolidated material (reclaim tunnel) should have two

entrances as far as practicable. Caution should be exercised to ensure that reclaim tunnels do not constitute a "confined space".

706. No person should be permitted to work on a face, wall or other location in an opencast mine from which a dangerous fall could occur unless they are:

(a) wearing a safety harness and lanyard of correct length, securely fixed to an anchorage above them; and

(b) are assisted by a competent person.

707. As far as practicable, where explosives are used, bench drilling should be carried out from the top of the bench. This provision should not prevent the drilling and firing of toe or other holes, but a combination of top-drilled and toe-drilled holes should be avoided, particularly if intended for sequential firing.

708. A working face should not be drilled or otherwise worked in a manner which will create an overhang of the face, and where unconsolidated rock is being mined, the face and sides should be rammed to prevent collapse. A face should not be undercut by the excavation of a slot at the toe of the face; this provision should not, however, prevent a tunnel or adit being driven into the face for drainage purposes.

709. At a mine where rock is being sluiced or mined by jets of water or other liquid, no person should be permitted to approach the top of the mine face to within a distance equal to twice the height of the face. When working of the jets is suspended, no person may enter the zone earlier excluded unless that zone has been examined and declared to be safe by a competent person. Before the resumption of jet operation all persons should again be withdrawn from that zone.

710. The maximum height of a working face in sandy material should not exceed the vertical reach of the excavating equipment working at the face. In cases where the projected total

depth of any sandpit excavation will exceed the vertical reach of the excavating equipment to be used, the pit should be worked by a series of benches.

711. Each bench should have separate loading arrangements and should be of sufficient length and breadth to provide safe working conditions. Sand pit faces should be worked over as large a width as is practicable, and at any cessation of operations for a period of time exceeding that of one shift, all pit faces should be sloped to prevent any further slump of sand. For the purpose of the present paragraph, the walls of a sand pit should be considered to be working faces. For the purposes of this Section, sand includes all unconsolidated materials or deposits.

712. Where manual workers are engaged on or ahead of overburden, stripping or mineral-winning phases, then there should either be a team of two workers or more working together, or any solitary worker should be kept under constant observation at all times.

10.5. Competence, education and training

10.5.1. General provisions

713. No person should be employed to work at an opencast mine unless that person has received the necessary instruction and training so as to be able to do the work competently and safely.

714. Prior to the commencement of mine operations, job tasks and job descriptions should be determined and a training needs assessment should be performed to determine training and competency needs.

715. National laws or regulations should establish standards for the training of all workers at opencast mines, including workers, supervisory officials and contractors. The employer

should prepare, and national laws or regulations require, a training plan which should specify:

(a) the induction and refresher training for workers in the industry;

(b) the competency required for persons assigned to new work;

(c) approved courses of training at a mining school or other approved place and, where practicable, the inclusion in the curriculum of training in OSH hazards, emergency response and first-aid techniques vital to saving lives;

(d) training and refresher training required when new systems of work are introduced;

(e) 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;

(f) the training and retraining of supervisory officials, examiners, electricians and other such personnel;

(g) the training of contract workers who work at the mine;

(h) the requirement that records of the training of each person be kept by a training officer appointed by the employer in charge of the mine; and

(i) 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 employer in charge of the mine.

716. Training programmes should:

(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.

717. 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, and should be in accordance with the identified needs, and include:

(a) pertinent aspects of relevant legislation, codes of practice and instructions on the prevention of accidents and disease and any collective agreement, such as the rights, responsibilities and duties of competent authorities, employers, contractors and workers;

(b) assessments, reviews and 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 mine fires and measures needed to prevent them and extinguish them should they occur;

(e) the hazards of unsafe walls, and the measures needed to prevent rock falls or collapses;

(f) hazard warning signs and symbols for hazardous ambient factors which may occur;

(g) any other relevant hazards;

(h) the health risks of inhalable and respirable dusts and hazardous and toxic substances and measures needed to prevent exposure and related diseases;

(i) procedures to be followed in an emergency, emergency measures, mine rescue, firefighting and fire prevention, and first aid;

(j) 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 workers to protect themselves;

(k) the nature and degree of hazards or risks to safety and health which may occur, including any factors which may influence that risk, such as appropriate hygiene practices;

(l) the correct and effective use of prevention, control and protection measures, especially engineering controls, and the responsibility of workers to use such measures properly;

(m) ergonomically correct methods for the handling of materials and tools;

(n) methods for identifying harmful chemicals and agents, including use of SDS which should be provided in languages and at educational levels that ensure they will be understood by workers;

(o) appropriate hygiene practices to prevent, for example, the transmission of hazardous substances off-site;

(p) cleaning, maintenance, storage and waste disposal, to the extent that these may cause exposure for the workers concerned;

(q) suitable instruction in the hazards connected with their work and in their working environment, as well as training in precautions necessary to avoid accidents, dangerous occurrences and occupational diseases; and

(r) training of safety and health representatives.

718. Training should be provided to workers 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 workers' representatives.

719. Employers should ensure that training and information requirements and procedures are kept under review, as part of the assessment review and documentation.

10.5.2. Qualifications of managers and supervisory officials

720. Each mine operation should have sufficient managers, supervisory officials, examiners, mining engineers, industrial hygienists and others responsible for the health and safety of the mining operation who have been certified as competent in accordance with national laws or regulations.

721. Candidates for certification of competency for positions such as mine managers, mine foremen, assistant mine foremen or deputies, and/or mine examiners or their equivalent, should have completed a specified number of years of practical work experience. Candidates for those positions should have to pass a test administered by the competent authority covering the various aspects of mining laws or national regulations related to mines, practices and conditions they would be dealing with in their official positions.

722. Successful management requires the integration of OSH into all the facility's activities, including contractors' activities.

723. Responsibility for managing OSH within any organization should be placed upon managers and supervisors 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 identification of hazards, assessments 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.

724. Managers should receive technical and other training to allow them to fulfil their responsibilities for OSH.

10.5.3. Qualifications, training and skills testing of workers

725. 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 exposed and the measures that need to 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 opencast mining;

(d) evaluate the education and training of workers to ensure its effectiveness.

726. 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 the work; and

(d) in relevant emergency procedures.

10.5.4. Qualifications of contractors and others working at the mine

727. The management of OSH with contractors and other parties should be consistent.

728. Best practices in OSH at the facility should be applied to contractors.

729. Only those contractors that can demonstrate good performance and an adequate safety and health management system should be used.

730. The OSH management systems of contractors and their OSH record should carry similar weight to other performance factors when considering the choice of contractors.

731. Before commencing work, on-site pre-work briefings should be completed which cover the scope of work, work method, identification of key hazards and risk assessment. All relevant safety permits should be completed before work is commenced and the mining worksites should be supervised and examined to the same standards that exist for the mining operation.

10.6. Personal protective equipment (PPE)

10.6.1. General

732. As a supplementary protection against exposure to hazardous conditions in opencast mining 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.

733. The minimum requirements for mandatory PPE on the mine should be established and communicated, for example, helmets, coveralls, safety glasses, safety boots and gloves.

734. Items of PPE provided should comply with the relevant national standards and criteria approved or recognized by the competent authority.

735. PPE should be issued as new to an individual worker and not interchanged unless it has been maintained and properly sanitized.

736. Those responsible for the management and operation of the personal protection programme should be trained:

(a) in the selection of the proper equipment;

(b) in assuring that it is correctly fitted to the people who use it;

(c) in the nature of the hazards and the adverse health effects of exposure and how the equipment is intended to protect against these; and

(d) in the consequences of poor performance or equipment failure.

737. PPE should be selected considering the characteristics of the wearer and 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 hazard identified at the facility and according to the information given by the manufacturer.

738. PPE should meet the requirements of Chapter 9 with respect to each hazard identified at the facility, for example, heat and cold stress, noise exposure, hazardous substances and vibration.

739. 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.

740. Different PPE and their components should be compatible with each other when they are worn together.

741. 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.

742. Employers should ensure that workers who are required to wear PPE are fully informed of the requirements and of the reason for wearing it, and are given adequate training in the selection, wearing, maintenance and storage of this equipment.

743. 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.

744. The PPE should not be used for longer than the time indicated by the manufacturer.

745. 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.

746. 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.

747. 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.

748. PPE should not contain hazardous substances.

10.6.2. Head protection

749. Helmets should be worn by all persons at the mine.

750. Any helmet that has been submitted to a heavy blow, even if there are no evident signs of damage, should be discarded.

751. If splits or cracks appear, or if a helmet shows signs of ageing or deterioration of the harness, the helmet should be discarded.

752. Where there is a hazard of contact with exposed conductive parts, only helmets made of non-conducting material should be used.

753. Helmets for persons working overhead should be provided with chin straps.

754. 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.

10.6.3. Face and eye protection

755. Face shields or eye protectors should be used to protect against flying particles, fumes, dust and chemical hazards.

756. Goggles, helmets or shields that give maximum eye protection for each welding and cutting process should be worn by operators, welders and their helpers.

757. 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, who should be appropriately protected.

758. With the use of face and eye protectors, due attention should be paid to comfort and efficiency.

759. The protectors should be fitted and adjusted by a person who has received training in this task.

760. 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.

761. Face and eye protectors should give adequate protection at all times, even with the use of corrective vision devices.

762. Eye protectors, including corrective lenses, should be made of appropriate impact-resistant material.

10.6.4. Upper and lower limb protection

763. Hands and feet should be protected against physical, chemical and other hazards.

764. The height to which safety footwear covers the ankle, knee or thigh depends on the hazard, although comfort and mobility should be considered.

765. Trouser legs should be pulled over the top of the boot and not tucked inside.

766. Slip, impact and acid-resistant properties should be taken into account when choosing footwear.

767. Knee protectors may be necessary, especially where work involves kneeling.

10.6.5. Respirators

768. 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.

769. 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.

770. 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.

771. 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.

772. 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.

773. 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.

774. Workers should be medically evaluated for their ability to wear a respirator safely before they are required to do so.

10.6.6. Hearing protection

775. 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.

776. 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.

777. 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.

778. 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.

779. 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.

780. 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.

10.6.7. Protection from falls

781. 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.

782. Devices should be provided to prevent workers from falling through floors and openings.

783. Safety harnesses should be worn where required and the lifeline should be attached to an adequate anchor point.

784. Appropriate and timely rescue should be provided when using fall-arrest equipment to prevent suspension trauma.

10.6.8. Work clothing

785. Where required on the basis of a risk assessment, workers should wear the appropriate protective clothing provided by the employer.

786. 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 requirements of workers to wear reflective clothing.

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

788. 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.

789. Inspection of protective clothing should be performed by the user before each use.

10.7. Ergonomics

10.7.1. Musculoskeletal injuries

10.7.1.1. Hazard description

790. 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 mining, and can cause musculoskeletal injuries.

791. These injuries comprise disorders of the muscles, joints and/or soft tissue (ligaments, tendons and capsules) that can arise from a variety of activities. They can occur suddenly as the result of jolts, jars and overexertion or a fall; or they may develop over months and years from repeated minor injuries or cumulative "wear and tear" on the joints, muscles and soft tissue. Long-lasting repetitive work movements and awkward postures may cause musculoskeletal injuries. Maintaining the same posture for extended periods causes excessive fatigue.

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

793. Too heavy a physical load may cause excessive fatigue, especially in a hot environment.

10.7.1.2. Assessment of risk

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

795. An appropriate ergonomic risk 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.

796. The competent authority, after consulting the representative organizations of employers and workers, should establish OSH requirements for repetitive work, working postures, physical load and the handling and transport of materials, particularly manual handling. Such requirements, technical standards and medical opinions should be used in the risk assessment, taking account of the relevant conditions in which the work is performed.

10.7.1.3. Control strategies

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

798. 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.

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

800. Workers should be informed about the hazards related to physical work, work postures, repetitive movements and lifting and carrying loads, including physical limits for force, frequency and posture.

801. Workers should be trained in using correct work techniques, where they have been established, to reduce the risk of disorders. They should receive all the necessary information about the process, equipment, their co-workers and any risks associated with the job in the correct form and in due time to enable them to complete the tasks without risks to their health and safety. Receipt of this information should be verified.

802. Work that is done intermittently or infrequently should be checked and temporary/contract workers should receive all the necessary information to undertake the job without risks to their health and safety.

10.7.2. Safety signs, alarms and communication

803. As far as is practicable, all opencast mines should use the same system of signs and safety colours which conform to accepted standards.

804. Road signs governing the circulation of vehicles at an opencast mine should be in accordance with those approved by the relevant competent authority. Any person entering the mine for the first time should be taught about all safety signs and colours and tested on this in their induction training.

805. When using written signs to convey a warning message, the type of language used in the message should be taken into account – use short statements in plain language, with symbols where appropriate. The colours of the sign, use of icons, the typeface and the suitable placement of the sign in the workplace also need to be considered.

806. The primary objective of safety signs is to warn or caution. The device should be conspicuous, recognizable and understandable. Signals or signs may fall into specific classifications of warning or caution, or hazard advisory or instructional. They need to meet accepted national, regional and ergonomics criteria.

807. 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, and may lead to dangerous occurrences and accidents.

10.7.2.1. Visual and auditory alarms

808. Visual alarms are appropriate when the worker is within the line of sight of the alarms, as in a cab or control room. Auditory alarms are necessary if the worker cannot be in the line of sight of visual alarms. However, if background workplace noise level exceeds 85dB(A) auditory alarms may not be heard. There are some basic guidelines for auditory alarms. They:

(a) may be used in addition to visual alarms to bring the worker's attention to a problem immediately;

(b) should not be used simply to indicate the status of the system;

(c) should be able to be heard and identified either through pitch or frequency or both; and

(d) should only be loud enough to draw the attention of those who need to be alerted.

809. Very loud signals are not acceptable. They may startle listeners, distract them in an emergency or a critical task, and cause temporary deafness. If they are regularly activated workers may be tempted to disable them.

810. Audible alarms are often unnecessary if the colour coding conventions for visual alarms are followed.

10.7.2.2. Electronic communications protocols

811. Protocols for communicating via radios or other electronic means should be established to ensure that the risk of misunderstanding is minimized, particularly for critical information. These protocols should be conveyed to all involved in such activities and strictly monitored.

10.7.2.3. Availability of information

812. All information to be made available to workers should be readily accessible, legible, understandable (for example, in appropriate languages) and up to date. Information available to workers at all times should include:

(a) the name of the mine, and the name and address of the mine operator;

(b) the name and appropriate contact details of relevant competent authorities;

(c) the national laws relevant to the mine;

(d) all relevant procedures (for example, those relating to excavation, traffic and shotfiring);

(e) all notices served by a competent authority; and

(f) information with respect to hazardous products as defined in the Global Harmonized System (GHS).

813. Workers should be made aware of how to access the information available to them. Account should be taken of the literacy of workers in making available information to them.

10.8. General precautions for frozen soil and permafrost

814. Where steam-thawing operations are practised, all steam pipelines should be heat insulated. Where steam lances are used for permafrost thawing, the steam hose should be firmly attached at both ends and equipped with safety chains at

the steam pipeline and at the lance point. Hoses should be regularly examined for defects and maintained in good condition.

815. Steam thawing should not be permitted under overhead power lines. No person should be permitted to approach steam or hot water points located under the soil unless these are covered by gangways. Electric thawing of frozen soils should only be carried out in accordance with a scheme – acceptable to a competent authority – which is designed to ensure that the work may be performed safely.

816. A steam pipeline network should be provided with pressure gauges installed at the exit of the main steam pipeline and at the end of the header into the section under treatment. The main steam supply should be disconnected before proceedings to rearrange any of the distribution pipes, to tighten flange connections, to mount or dismount valves and plugs, or to connect and disconnect hoses.

817. Sink holes and fall-through funnels formed around thawing points should be fenced or closed off.

11. Work organization

11.1. Job safety analysis

818. 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 task as safely as possible. Special attention should be given to maintenance tasks.

819. Where the job safety analysis does not identify suitable controls to protect workers' safety, the task should not be undertaken.

820. 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.

821. The SWPs applicable to each task should be readily available to the workers involved. Workers should be trained in the relevant SWPs and these should be reviewed with each such worker or work crew assigned to the task before the first time they perform it, and frequently thereafter.

822. 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.

11.2. Work teams

823. The employer should ensure that work teams are resourced adequately to undertake the assigned tasks safely.

11.3. Persons working alone

824. Working alone should be avoided. If it is necessary, the employer should take appropriate measures for the protection of workers working alone or in isolation.

11.4. Admission of outside persons

825. Any person not employed at a mine should not be allowed to enter the mine, unless permitted by the employer in charge of the mine to do so and accompanied by a responsible and competent person. A record should be kept of both the arrival and departure of all visitors to an opencast mine.

826. The provision of adequate visitor safety and health induction training is an important consideration. While on-site, all visitors should be adequately supervised. 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 supervisory officials or the accompanying responsible person with a view to ensuring their safety and that of the workers and the mine.

11.5. Small-scale artisanal mining activity

827. Artisanal and small-scale mining provides work and income for millions of people. Despite attempts in a number of ILO member States to create appropriate legal and regulatory frameworks, which include monitoring and enforcement provisions, and programmes to improve the working methods of small-scale artisanal miners (ASMers), its potential as a source of decent work and rural development has not been widely realized. Until now, small-scale mining has typically suffered from decent work deficits, such as child labour and, particularly in conflict or post-war areas, forced labour.

828. Small-scale mining may not only lead to very poor OSH conditions for small-scale miners, but can also have repercussions on the OSH of workers in large-scale mines. Particularly dangerous forms of ASM activities are those in which ASMers may be trespassing and where they work in abandoned areas, in tailings dams or upstream from larger operations. As some activities of ASMers can have negative repercussions on the structural soundness of the opencast mine concerned, there is a need for companies to understand what ASMers are doing, what possible side effects their work may have and to find ways that would allow them to pursue their operations without putting at risk a mine, workings or other sections of a mine, such as a tailings dam.

829. In accordance with national laws and regulations, interactions between large-scale mines and small-scale miners should not, however, be limited only to countering possible deterioration of structures put in place.

830. Mines should also consider ways in which they could directly assist ASMers in achieving decent work (for example, by having their workers act as mentors to ASMers), or assisting employers' and workers' organizations in their efforts to improve the operations and social conditions of ASMers.

831. Further information can be found in the conclusions of the Tripartite Meeting on Social and Labour Issues in Small-scale Mines (ILO, 1999) and *Working Together: How large-scale mining can engage with artisanal and small-scale miners* (ICMM/CASM/IFC CommDev, 2010).

12. Special protection

12.1. General welfare

832. National laws or regulations should specify the requirements for the changing, storing and drying of clothes, and for canteen, restroom and laundry facilities, as well as toilets, showers and washbasins to be provided at mines.

833. As a minimum, the following should be provided:

(a) sufficient and suitable toilets, showers, washbasins and laundry facilities;

(b) adequate supplies of clean drinking water in suitable places and properly maintained; and

(c) based on the nature of the mine and its operations, adequate facilities for the changing, storage, laundering and drying of clothes.

834. At opencast mines where it is not practicable to set up canteens providing nutritious meals and, if necessary, in mines where such canteens already exist, messroom facilities should be provided for individual workers to prepare food or to heat and eat meals brought by themselves.

835. Where practicable, and as required, mobile canteens should be provided for the sale of nutritious meals to workers.

836. During mealtimes and other work breaks, workers should be protected from extremes of temperature and extreme weather conditions. The necessary arrangements should be made to ensure the regular maintenance in a clean and sanitary condition of all the facilities provided.

837. When required, adequate transport facilities should be arranged to meet the needs of shiftworkers at suitable times of the day and night. Where, in the interests of health and safety and to avoid excessive fatigue, it appears necessary for persons to be transported to and from their places of work, suitable transport should be provided.

12.2. Personal hygiene

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

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

840. Suitable toilets should be provided by the employer with handwashing facilities and soap.

841. Toilets, washing facilities and areas set aside for eating should be kept clean and in a hygienic condition by the employer. The type of washing facilities should be related to the nature and degree of exposure.

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

843. 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.

12.3. Alcohol and drug use

844. Problems relating to alcohol and drug use may arise from personal, family or social factors, or from certain work situations, or from a combination of these elements. Such problems

not only have an adverse effect on the health and well-being of workers, but may also cause difficulties at work, including a deterioration in job performance. As there are multiple causes of alcohol- and drug-related problems, there are consequently multiple approaches to prevention, assistance, treatment and rehabilitation.

845. Alcohol and other drug policies and programmes should promote the prevention, reduction and management of alcohol- and drug-related problems in the workplace. Management and workers and their representatives should cooperate in developing such programmes. The same restrictions or prohibitions with respect to alcohol should apply to both management and workers.

846. 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.

847. 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 fundamental principles and rights at work.[1] Any information communicated should be treated with confidentiality.

848. 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.

849. Further information can be found in *Management of alcohol- and drug-related issues in the workplace*, an ILO code of

[1] In accordance with the 1998 Declaration on Fundamental Principles and Rights at Work.

practice, 1996; and *Alcohol and drug problems at work: The shift to prevention* (ILO, 2003).

12.4. HIV and AIDS

850. HIV and AIDS should be treated like any other chronic illness/condition in the workplace.

851. The ILO HIV and AIDS Recommendation, 2010 (No. 200), and the ILO code of practice on HIV and AIDS and the world of work should be instrumental in helping to prevent the spread of the pandemic, mitigate its impact on workers and their families and provide social protection to help cope with the disease.

852. 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.

853. There should be no disciplinary action nor discrimination against workers on the basis of ongoing medical care or real or perceived HIV status. Real or perceived HIV status should not be a cause for termination of employment. Temporary absence from work because of illness or caregiving duties related to HIV or AIDS should be treated in the same way as absences for other health reasons.

854. Persons with HIV-related illness should not be denied the possibility of continuing to carry out their work, with reasonable accommodation if necessary, for as long as they are medically fit to do so. Measures to redeploy such persons to work reasonably adapted to their abilities, to find other work

through training or to facilitate their return to work should be encouraged.

855. In workplaces, it is recommended to have an HIV and AIDS policy and programme, the successful implementation of which requires cooperation and trust between employers, workers and their representatives. The active participation of both men and women should be promoted in the HIV response, regardless of sexual orientation.

856. When there is a possibility of exposure to HIV at work, workers should receive education and training on modes of transmission and measures to prevent exposure and infection. Awareness-raising measures should emphasize that HIV is not transmitted by casual physical contact and that the presence of a person living with HIV should not be considered a workplace hazard.

857. There should be no discrimination against workers living with HIV or AIDS in access to and receipt of benefits from statutory social security programmes and occupational health services.

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 opencast mining. 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 187 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) and the Protocol of 2014
- Abolition of Forced Labour Convention, 1957 (No. 105)

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) and Recommendation (No. 81), 1947
- Radiation Protection Convention (No. 115) and Recommendation (No. 114), 1960
- Reduction of Hours of Work Recommendation (No. 116), 1962
- 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) and Recommendation (No. 143), 1971
- 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
- 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
- Asbestos Convention (No. 162) and Recommendation (No. 172), 1986
- 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 (No. 194), 2002 (as well as the ILO List of Occupational Diseases (revised 2010))
- Promotional Framework for Occupational Safety and Health Convention (No. 187) and Recommendation (No. 197), 2006
- Recommendation concerning HIV and AIDS and the World of Work (No. 200), 2010

2. Selected ILO codes of practice with provisions which are relevant and applicable to opencast mining

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- *Occupational exposure to airborne substances harmful to health*, 1980
- *Safety in the use of asbestos*, 1984
- *Radiation protection of workers (ionizing radiations)*, 1987
- *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
- *Protection of workers' personal data*, 1997
- *Ambient factors in the workplace*, 2001
- *HIV/AIDS and the world of work*, 2001
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4. Relevant online information

Radiation Safety Institute of Canada. Online training courses: http://onlinelearning.radiationsafety.ca/

Appendix I

Workers' health surveillance
(adapted from ILO *Technical and ethical guidelines for workers' health surveillance*, Geneva, 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 the primary prevention of occupational and work-related injuries and diseases;

(b) under controlled conditions 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 the occupational hazards and risks in the workplace which may affect workers' health;

(b) the health requirements of the work and the health status of the working population;

(c) the relevant laws and regulations and the available resources;

(d) the awareness of workers and employers of the functions and purposes of such surveillance;

(e) the fact that surveillance is not a substitute for monitoring and control of the working environment.

2.2. In accordance with the needs and available resources, workers' health surveillance should be carried out at the 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, for example, within an 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; or

(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 analysis and evaluation with regard to quality and intended use;

(c) determine action and follow-up, including:

(i) guidance on health policies and OSH programmes; and

(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 OSH 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 workers with 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 the health of the individual;

(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 to 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;

(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 worker's 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* (Geneva, 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* (Geneva, 1997);

(b) be used to protect the health of workers (physical, mental and social well-being) individually and collectively, in accordance with the ILO *Technical and ethical guidelines for workers' health surveillance*.

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 for the time and under the conditions prescribed by national laws and regulations, with appropriate arrangements to ensure that workers' health surveillance records are securely maintained in the case of establishments that have closed down.

Appendix II

Surveillance of the working environment
(based on 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 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 PPE;
   (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 they exist.

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 these data. They 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 they exist.
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 their employment, and with due regard to the necessity for workers to participate in OSH matters, 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.

7. 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.

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

Appendix III

Occupational exposure limits for hazardous substances, heat, noise and vibration

1. Purpose

1.1. This appendix 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 appendix to list values, because these change continually as more technical information becomes available, and it is the responsibility of the competent authority to specify which exposure limits should be used and how.

1.2. Certain standard-setting bodies rely on technical expertise only. They do not accurately reflect the views of the social partners, for example, trade unions. This should be taken into account when referring to the standards mentioned in this appendix.

2. General

2.1. An exposure limit (EL) is a level of exposure specified by a competent authority, or some other authoritative organization such as a professional body, as an indicator of the level to which workers can be exposed without serious injury. It is used as a general term and covers the various expressions employed in national lists, such as "maximum allowable concentration", "threshold limit value", "permissible level", "limit value", "average limit value", "permissible limit", "occupational exposure limit", "industrial hygiene standards", and so on. The exact definition and intended application of ELs vary widely from one authority

to another, and the underlying definitions and assumptions and the requirements of the appropriate competent authority 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.

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, online edition, 2012). Some references concerning ELs for particular ambient factors are given in the following sections.

4. Hazardous substances

4.1. ELs for solids and non-volatile liquids are usually in mg/m^3 (milligrams of the chemical in a cubic metre of air). ELs for gases and vapours are usually in ppm (parts of the substance in a million parts of air, by volume), and also in mg/m^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 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).

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, are 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 appendix) 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.

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 5349-1:2001 provides guidelines for measurement).

Appendix IV

Supplementary measures relating to boilers and pressure vessels[1]

Boilers and steam plant

Every boiler installed at an opencast mine, whether separate or part of a range, should be provided with:

(a) one or more appropriate safety valves, the setting of which should only be altered by a competent person;

(b) appropriate steam and water gauges to show respectively the pressure and the height of the water in that boiler; and

(c) effective guarding or other protection for the gauges provided on each boiler.

The maximum pressure at which steam should be generated and the blow-off pressure should both be marked on each steam gauge, and all relevant persons should be made familiar with this arrangement.

Boilers and steam plant should be treated the same as other machinery under the Machinery code and should be included in the machinery control plan.

Compressed air plant

Any air compressor used at a mine should be so designed, constructed, operated and maintained that:

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[1] To be read in conjunction with the ILO code of practice Safety and health in the use of machinery (Geneva, 2013) (the "Machinery code"), in particular Chapter 8 – Supplementary measures relating to specific machinary types.

(a) air entering the compressor is as dry, clean and cool as is practicable;

(b) the maximum temperature of the air in the compressor is safely below the flashpoint of the compressor lubricating oil (for example, below 30°C); and

(c) the compressor is stopped either manually or automatically if the air temperature becomes too high (for example, due to an interruption in the flow of fluid used in the compressor cooling system).

Pressure vessels used as air-receiver tanks should:

(a) be equipped with one or more automatic pressure-relief valves, which prevent pressure from exceeding the maximum allowable working pressure by not more than 10 per cent; and

(b) also be equipped with pressure gauges which accurately indicate the internal pressure.

Pressurized hose lines should be kept secure and persons protected from injury from the escape of compressed air. Compressed air plant should be treated the same as other machinery under the Machinery code and should be included in the machinery control plan for an opencast mine.

Standards for boilers and pressure vessels

Boilers and pressure vessels should be compliant with national laws and any relevant accepted standards.

Safety and health in opencast mines

The original code of practice *Safety and health in opencast mines* was published in 1991. This revised code, adopted in October 2017 by a Meeting of Experts drawing upon the knowledge and experience of governments, employers, workers and other participants, 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 (OSH), including the Safety and Health in Mines Convention, 1995 (No. 176). To this effect, the new code is based on the principles of the Convention, including risk assessment, addresses issues such as the interaction between large-scale and small-scale artisanal miners and also comprises a section on automated machinery, a development that has great potential to change the work carried out by nearly all workers in opencast mines worldwide.

ISBN 978-92-2-131709-8