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Mining and quarrying — Health and safety requirements —

Part 4: Underground mining

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In order to match with technological development and to keep continuous progress in industries, standards are subject to periodic review. Users shall ascertain that they are in possession of the latest edition

Rwanda Standards Board

P.O Box 7099 Kigali-Rwanda

KK 15 Rd, 49

Tel. +250 788303492

Toll Free: 3250

E-mail: info@rsb.gov.rw

Website: www.rsb.gov.rw

ePortal: www.portal.rsb.gov.rw

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Foreword

Rwanda Standards are prepared by Technical Committees and approved by Rwanda Standards Board (RSB) Board of Directors in accordance with the procedures of RSB, in compliance with Annex 3 of the WTO/TBT agreement on the preparation, adoption and application of standards.

The main task of technical committees is to prepare national standards. Final Draft Rwanda Standards adopted by Technical committees are ratified by members of RSB Board of Directors for publication and gazettment as Rwanda Standards.

DRS 117-4 was prepared by Technical Committee RSB/TC 57, *Mining and related activities.*

In the preparation of this standard, reference was made to the following standard:

MINING SAFETY STANDARDS of March 2016 (Revised in December 2020). Rwanda Mines, Petroleum and Gas Board (RMB)

The assistance derived from the above source is hereby acknowledged with thanks.

RS 117 consists of the following parts, under the general title *Mining and quarrying*:

— *Part 1: Code of practice*

— *Part 2: General requirements*

— Part 3: *Open pit mining*

— Part 4: *Underground mining*

— *Part 5: Blasting*

Committee membership

The following organizations were represented on the Technical Committee on *Mining and related activities* (RSB/TC 57) in the preparation of this standard.

CIMERWA Plc

D&D Resources Ltd

Integrated Polytechnic Regional College (IPRC) - Karongi

Inter-African Mining Corporation (IMC) Ltd

LuNa Smelter Ltd

New Bugarama Mining (NBM) Ltd

Ngali Mining Ltd

Ngororero Mining Company (NMC) Ltd

Piran Rwanda Ltd

Rutongo Mines Ltd

Rwanda Environment Management Authority (REMA)

Rwanda Extractive Industry Workers Union (REWU)

Rwanda Housing Authority (RHA)

Rwanda Mines, Petroleum and Gas Board (RMB)

Rwanda Quarries Association (RQA)

Standards for Sustainability (SfS)

Trinity Metals

University of Rwanda - School of Mining and Geology (UR - SMG)

Wolfram Mining and Processing (WMP) Ltd

Rwanda Standards Board (RSB) – Secretariat

Introduction

Mining and quarrying sector implies health and safety management to prevent harm to workers at the site. This responsibility imposes duties and promotes excellent health and safety management by employers. The environmental issues, safety and human rights should be the major concern of employers during the whole process of mining and quarrying production.

The present standards on health and safety requirements for mines and quarries is designed to support the national mining law and includes other subjects that are not dealt with in the current law on mine and quarry operations and that may have an influence on mineral traceability, transparency, good practice and on the environmental impact of mining and quarrying operations for mineral certification system by an independent certifier based on the levels of compliance with the requirements provided in this document.

Mines and quarries —Health and safety requirements — Part 4: Underground mining

1 Scope

This Draft Rwanda Standard provides health and safety requirements for underground mining. It gives requirements on how to make the working area safe, support of mining tunnels, mine ventilation as well as air compressors and underground lighting.

Requirements for blasting are covered in DRS 117-5 whereas DRS 117-2 covers general requirements for health and safety in mining and quarries.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 23872, *Mining structures — Underground structures*

RS 407-2, *Emission limits — Performance evaluation Part 2: Non-road mobile machinery*

RS 427, *Round and sawn timber — Nomenclature of timbers used in Rwanda*

RS EAS 325, *Wood preservatives and treated timber — Guide to sampling and preparation of wood preservatives and treated timber for analysis*

3 Terms and definitions

For the purposes of this standard, the following terms and definitions apply.

3.1

law

national law regulating specified operations in Rwanda

Note 1 to entry: Example of national law includes the law regulating mining and quarry operations in Rwanda, and law regulating labour Rwanda.

3.2

employer

company or cooperative that employs workers at the mining site

3.3

mine operator

representative of the holder of the exploitation license

Note 1 to entry: An example of the mine operator could be the Director, Manager or Chief Executive Officer of the license holder

3.4

minerals industry

companies and co-operatives engaged in exploration and extraction of minerals including metallic minerals, industrial minerals, non-metallic minerals, sand aggregate and gravel and clay

3.5

hazard identification

process of recognizing that a hazard exists and defining its characteristics

3.6

hazard

source or a situation with a potential for harm in terms of human injury, ill-health, damage to property, damage to the environment, or a combination of these

3.7

harm

that does not usually occur, or usually is not easily detectable, until a significant time after exposure to the hazard

3.8

holder

individual or institution in whose name a mining right is registered

3.9

mine

any place, quarry, pit, shaft, drive, level or other excavation, and any drift, gutter, lead, vein, lode, reef, saltpan or working, in or on or by means of which any operation connected with mining is carried on, together with all buildings, premises, erections and appliances, whether above or below the ground, that are used in connection with any such operation or for the extraction, treatment or preparation of any mineral or for the purpose of dressing mineral ores

3.10

adit

horizontal or nearly horizontal tunnel driven from the surface for the working of a mine

3.11

mineral

substance of economic value obtained by mining

[SOURCE ISO 22932-2:2020, 3.13.4]

3.12

mining

extraction of material, whether solid, liquid or gaseous from land or from beneath the surface of the earth in order to win minerals and includes any operations directly or indirectly necessary or incidental thereto

3.13

mining area

area of land subject to a mineral licence granted under the law regulating the issuance of mineral licence or mining licence

3.14

mining operations

operations carried out in the course of mining

3.15

mining plant

any building, plant, machinery equipment, tools or other property that has been used for mining, whether or not affixed to land, but does not include any timber or other material used or applied in the construction or support of any shaft, drive, gallery, terrace, race, dam or other work

3.16

mineral licence

mining licence, quarry licence or an exploration licence, granted under the law

3.17

risk

combination of the likelihood and consequences of a specified hazardous event occurring

3.18

risk assessment

overall process of estimating the magnitude of risk and deciding whether or not the risk is tolerable or acceptable

3.19

abandoned place

any place where work has ceased and through which persons no longer travel

3.20

barricade

structure designed to prevent the entry of persons to an area

3.21

competent person

person having the knowledge, experience, skill, and qualifications to carry out a particular task of supervision, drilling, blasting, plumbing, mining, electrical, civil and mechanical technician in mining as deemed as adequate by the Competent Authority upon assessment

Note 1 to entry: The qualifications and experience for competent persons shall be set by the Competent Authority.

3.22

competent authority

public institution responsible for implementing national standards, laws and regulations related to mining and quarrying operations

Note 1 to entry: Competent Authority includes the authority in charge of mines and quarries, the authority in charge of environment management, the authority in charge of labour, investment or the local authority.

3.23

machinery

assembly of linked parts or components, at least one of which moves, with appropriate machine actuators, control and power circuits, joined together for a specific application, in particular for the processing, treatment, moving or packaging of a material

[SOURCE ISO 14159:2002, 3.13]

3.24

incident

unplanned event which results in damage or production loss but does not result in harm

3.25

inspector

personnel appointed by the Competent Authority in charge of mining and quarrying operations in Rwanda

3.26

quarry

any working open to the surface beneath the original surface for the purpose of extracting building or industrial minerals

3.27

accident

any unplanned event which results in harm

3.28

near miss/potential incident

unplanned event, which under slightly different circumstances, could have resulted in an incident/accident

3.29

ladder way

part of any shaft, or raise where permanent ladders are installed for the use of persons travelling

Note 1 to entry: ladder includes a step ladder, a chain ladder, and extension ladder

3.30

employer

any physical or moral, public or private person that employs one or several workers, even in a discontinuous way

3.31

worker

any person who commits him/herself to put his/her professional activity in return for payment under the direction and authority of another physical or moral, public or private person

Note 1 to entry: worker includes employees, sub-contractors and artisanal miners

3.32

inspector of labour

person appointed as inspector of labour under the law governing labour in Rwanda

3.33

employers' professional organization

association of employers executing similar or related professions with the exclusive purpose of studying and defending their economic, and social interests

3.34

workplace

places where workers carry out their services, or where an employer carries out or directs two or several operations that are independent due to their size or mission. Each of these operations constitutes a separate workplace. A workplace may also be a place where one travels to or where the worker performs his/her functions while on mission

3.35

mining area

part of or whole mine where excavation operations are carried out or have been carried out previously

3.36

professional organization

organization that aims at advancing a particular profession, support the interests of people working in that profession and serve the public good

Note 1 to entry: Professional organization can also be referred to as a professional association or professional body

3.37

owner

person holding a valid mining or quarry licence

Note 1 to entry: The owner can be an individual or an organization

3.38

manager

person directly appointed by the owner

Note 1 to entry: The owner can be the manager.

3.39

employee

person having agreed to work for an employer under a contract concluded between them, and in return for remuneration

4 Underground mine excavations

4.1 General

In addition to the requirements of ISO 23872, the requirements specified below shall also apply.

4.2 Underground mine plan

4.2.1 At all mine sites, underground mine plans including mine layout shall be prepared and held at the site office to facilitate emergency responses and prevent injury and damage to services.

4.2.2 An underground plan shall show:

a) any shaft, stope, station, permanent magazine, main drive, main crosscut, main raise, main wins, major fault and major dyke;

b) any abandoned working which is adjacent to the mine workings together with an explanatory note stating specifically the degree of accuracy on which such plan is based;

c) the date, month and year marked against the current position of all workings every year so that any change or advance of the workings can be easily ascertained with reasonable accuracy;

4.2.3 Mine Plans shall be laid down on a scale of 1/500, 1/1,000, 1/1,500, 1/2,000, 1/2,500, 1/5,000. However, the Competent Authority may approve in writing any other scale at his discretion.

4.2.4 The following requirements shall be fulfilled in order to operate in underground mines:

d) the angle of the inclined entrance should be no more than 45^0 in hard and solid rock area; in softer and more unstable areas it should be no more than 10^0. The distance between two vertical/inclined or horizontal entrances should be no less than 20 m. This distance and angle can only be changed if the laboratory's

geotechnical data indicates that the rock is competent enough, and this data shall be kept at site company's office;

e) every entrance to any dangerous place or any underground place that has been abandoned shall be adequately fenced or barricaded across the whole width of such entrance and a notice forbidding entry shall be displayed at each entrance so as to prevent unintentional access to such place, and no person shall enter or be permitted to enter any such place unless authorized to do so by responsible person.

f) depending on the characteristics of the mineral deposit, such as the ore vein location and the hardness of the rock, entrance to the mine shall be vertically, horizontally or inclined. The area for the entrance need to be chosen after carefully inspecting the solidity of the rock in order to ensure the mine entrance not to be collapse. In addition, the mine entrance shall be located in area where there is no slippage or risk of flooding; and

g) each mining site shall have a standard established on the number of personnel to carry out the work underground depending on the size of the heading or end and amount of air.

4.2.5 The mine shall clearly define the minimum size of the main tunnels depending on the method of mining and equipment and shall not be less than 1.50 x 1.80 meters in the main drive.

4.2.6 The mine shall define the size of the other development drifts depending on number of employees, ventilation and mining technology to be employed. However, the minimum size shall not be less than 1x1.6 m. Access to underground mine working areas.

4.2.7 The access points shall be used for transportation of people and materials and shall at all times be maintained in safe conditions at all times. In this case, a log book detailing examinations carried out, condition of the access and remedies carried out shall be maintained at site. Annex B gives a typical example of working logbook.

4.3 Second means of access and egress

4.3.1 Mining production shall commence when at least one entrance (secondary exit) has been built and connected to the main underground opening (tunnel). The Competent Authority may require operators to install more exits where necessary.

4.3.2 The second access shall serve dual purpose of ventilation and exit route in case of emergency evacuation.

4.3.3 The access shall be developed in such a way that it is usable for safe evacuations as well as intake/outlet of air.

4.3.4 The second access shall be kept in a condition in which it is safe to use and is free of obstruction on the walkways.

4.3.5 Regular and period examinations shall be carried out for the second means of access.

4.3.6 A log book, in accordance with Annex I, detailing examinations carried out, condition of the access and remedies carried out shall be maintained at site.

4.4 Access to working areas through adits

4.4.1 The adit shall serve as one of the main fresh air intakes into the mine and for accessing the underground working by personnel as well as transportation of ore/waste.

4.4.2 Tunnels shall be excavated in such a way that the incline angle is not more 45 degrees for safety of employees during access to development ends as well as when transporting ore and waste from the ends. Where a tunnel incline angle exceeds 45 degrees, the tunnel shall be fitted with steps with ladders on foot or walkways.

4.4.3 Where stairs are excavated on the ground, side handrails shall be provided to provide support to a person ascending or descending the travel way. The stairs that are dug into the ground shall be between 15 cm and 30 cm high apart of the span.

4.4.4 Stability of the travelway roofs and side walls shall be inspected regularly to ensure any loose rocks are scaled down or supported accordingly.

4.4.5 Wherever practical, the tunnel shall be excavated at a positive gradient of +0.5 degrees to allow water draining.

4.4.6 The Mine Manager/Technician shall put in force a code of safe practice covering all work in adits and a supervisor to undertake the responsibility for the safe operations and maintenance of the shafts.

4.4.7 Where manual labour is involved, health consideration shall be taken into effect on the weight of the materials, distance covered and fatigue management process.

4.4.8 As a requirement, examinations shall be carried out at different frequencies for the condition of the adit and transportation ways as per mine procedure.

4.4.9 A log book detailing examinations carried out, condition of the access and remedies carried out shall maintained at site.

4.5 Access to working areas through shafts

4.5.1 General

4.5.1.1 The shaft shall be developed in such a manner that it serves as one of the main fresh air in-takes into the mine as well as lowering of personnel and hoisting of ore/waste through the shaft.

4.5.1.2 A clear partition separating the hoisting and manway shall be provided and made safe.

4.5.1.3 The manway/travelway shall be provided with ladders and platforms between levels that are properly constructed and decked to prevent any potential of any material being unknowingly dropped or dislodged below.

4.5.1.4 Every manway/travel way shall have an access area with safe means of entering and exiting and with adequate clearance from pipes, cables or other services for people using it.

4.5.1.5 Stability of the travel ways roofs and side walls shall be inspected regularly to ensure any loose rocks are scaled down or supported accordingly.

4.5.1.6 Ore from the mine loading areas shall be hoisted and tipped at the surface stockpiles.

4.5.1.7 Mine Manager/Technician shall put in force a code of safe practice covering all work in underground and appoint a supervisor, as a responsible person to undertake the responsibility for the safe operations and maintenance of the shafts.

4.5.1.8 Where manual labour in lifting of waste/ore is involved, health consideration shall be taken into effect on following:

a) the weight of the materials;

b) distance covered; and

c) fatigue management process.

4.5.1.9 The hoisting mechanism through the shaft shall be installed in such a way that it has a built-in braking mechanism.

4.5.1.10 As a requirement, examinations shall be carried out at different frequencies for the shaft and the different winding equipment as per mine procedure.

4.5.1.11 A log book on the examinations of the shaft shall be maintained at the site at all times.

5 Making the working area safe

5.1 Working place examination for potential falls of ground checklist

5.1.1 The Manager shall appoint a responsible person who shall identify all loose ground (rocks and soil), geological disturbances and take remedial action to ensure that no ground falls are left uncontrolled.

5.1.2 The checklist using the following conditions shall be carried out before the commencement of work:

a) has an early examination of the area been carried out?

b) are all the personnel in the area able to recognize poor ground conditions?

c) is ground condition good?

d) is ground condition fair?

e) is ground condition poor?

5.1.1 Mine shaft

5.1.1.1 Minimum of cross-section 2 m x 2 m of the main vertical shaft shall be followed.

5.1.1.2 The mine shall define the size of inside shafts depending on number of employees, ventilation and mining technology to be employed. However, the minimum size shall not be less than 1x1 m.

5.1.1.3 The following guidelines shall be followed to construct a main vertical shaft:

a) vertical shafts are dug to allow people to enter and exit mines, to take out ore, and for ventilation;

b) they shall be straight at a 90-degree angle and be free from obstacles along the walls that could impede the lowering and lifting of miners and ore; and

c) the load shall be lifted precisely in the middle of the shaft.

5.1.1.1 Supporting a main vertical shaft

5.1.1.1.1 Mining shafts shall be supported both inside and outside in order to prevent collapses and landslides. The softer, looser rock areas of the shaft need to be supported by timber frames with joined notches. Other materials such as stones, concrete, wood, and sandbags can also be used as shaft supports.

5.1.1.1.2 The rock layer beneath the soil is comprised of different kinds of rocks, which are classified as either stable or unstable. The topsoil on the surface is generally unstable and loose, therefore it is necessary to ensure there is proper support for shaft entrances.

5.1.1.2 Guidelines on how to support a main vertical shaft using timber

The softer, looser rock areas of the shaft shall be supported with timber frames with joined notches. This prevents the surrounding rock from heaving, preserve the dimensions of the cross-section, and absorb rock pressure. In areas where there is a higher risk of collapse, the timber supports shall be more tightly positioned. When the shaft reaches the hard and stable rock, the distance between the support frames can be increased accordingly.

5.1.1.3 Supporting shaft collar

The following steps shall be following while supporting shaft collars:

d) a shaft wall support shall continue 20 cm above the surface;

e) the shaft collar shall be framed with thick planks of wood/timber to prevent collapse and the flow of rainwater;

f) trenches shall be dug around the entrance to the shaft to channel the flow of rainwater;

g) the position of windlass legs should be marked when making the shaft collar support;

h) the area around the shaft should be regularly cleaned;

i) locks can be used to tighten the timber in unstable rock areas; and

j) the timber used for locking shall be positioned at the boundary between stable and unstable rock areas, in order to make locks, holes called cups are made in the walls of the shaft. The timber is then positioned across the shaft with the ends placed in the cups. The cups are then filled with stones and sand for stability. Wooden support frames are placed on top of the locks in unstable rock areas.

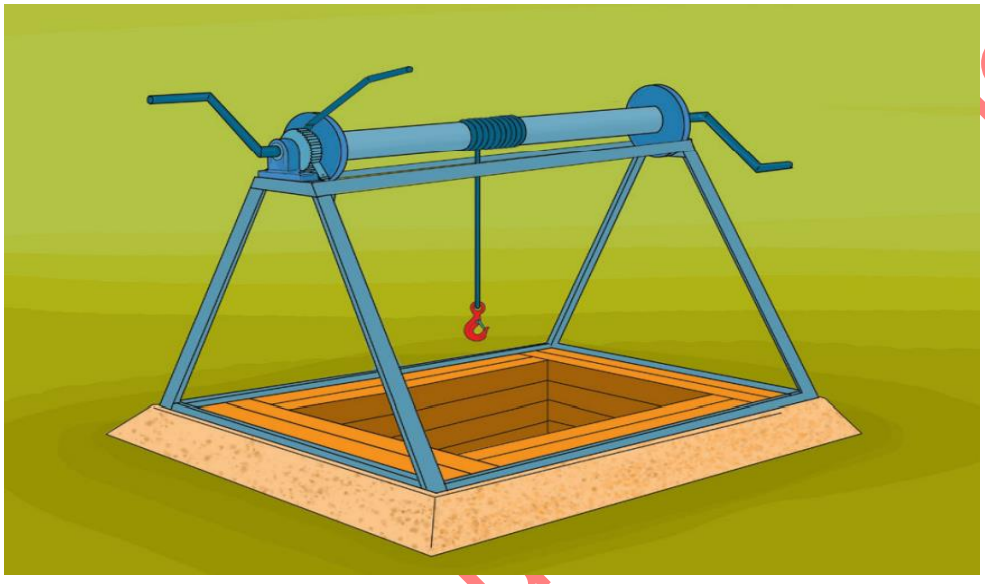

Figure 1 — Typical example of a shaft collar

5.1.1.4 Windlasses and ropes

5.1.1.4.1 Ropes used in mine hoisting shall meet requirements specified in RS ISO 5614. The following precautions shall be considered while operating windlasses:

a) do not lift a load that is heavier than the maximum carrying capacity;

b) regular maintenance work on windlass frames shall be conducted in accordance with applicable standards and/or safety procedures;

c) undertake regular inspections of the windlass and replace worn-out parts;

d) windlass chains shall be regularly cleaned and painted at least once a year in order to prevent rusting;

e) unless the winding plant is such that it does not allow of the hoisting rope being cut for test, the rope shall be recapped at intervals not exceeding six months, a sample being cut from the rope during this operation and having its ends served with binding wire to prevent disturbances of the strands; the sample shall be properly prepared and sent to a reliable laboratory for a breaking load test; the certificate of test shall be retained and brief particulars thereof shall be documented in the rope record book; and

f) maintenance shall be conducted as per manufacturer's instructions. Details shall be documented in the rope record book and shall be kept at mine site.

5.1.1.4.2 Every windlass shall be provided with a pawl and brake maintained in good working order to prevent the load from descending accidentally.

6 Support of mining tunnels

6.1 Timber and mine support guidelines

6.1.1 Support systems shall be designed, selected, used, installed, maintained and removed taking into consideration of the various rock conditions that may prevail.

6.1.2 The Manager shall appoint a responsible person to ensure that particular attention is given to the support of the area in the vicinity of the working face. In this regard, the timing of the installation and removal of temporary and primary support is important and, together with examination and making safe procedures, shall be specifically dealt with.

6.1.3 In small scale mining, underground development support shall focus on the installation and maintenance of supports in the stressed areas, main haulages or tunnels and traveling ways.

6.1.4 Timber sets shall be used to support excavations that have been driven through poor to very poor ground conditions or temporary excavations. Timber sets can be installed in haulages, material cross cuts, service drifts and undercuts and any other excavations or openings where the limitations of span and height shall permit.

6.1.5 Square timber sets shall be used in main drives, three-piece timber sets in smaller drives and undercuts, false cap and pony sets for various tunnel/excavations configurations to provide passive support of hanging and side walls.

6.2 Materials and tools requirements for timber support work.

6.2.1 Required tools for framing and installation of timber sets are:

a) nails (100mm – 150mm);

b) at least a 4 Kg Hammer;

c) bow saw;

d) shovel (also pick);

e) timber-mans' staff;

f) twine; and

g) pinch bar.

6.2.2 The framing of timber usually includes cutting it to size, notching, cutting daps, mortising for joints, removing slabs from round timber and any other applications.

6.2.3 As such, other timber framing tools are needed, e.g., small hand-held chainsaws, circular saws, drills and others. A swing-saw for end-cutting and a permanently mounted power-saw for making wedges are necessary at the timber shop.

6.2.4 Additional tools for squaring logs and cutting planks for lagging and blocking are usually necessary for the timber shop.

6.3 Timber type and size selection

6.3.1 Long-grained hardwood timber with sufficient elasticity and strength shall be used for mine roof support. Timber used and nominal loads shall be in accordance with ISO 23872 and RS 427.

NOTE This means that when a timber prop is subjected to pressure on its ends, it bows outwards considerably without breaking while still resisting the applied pressure. Long-grained timber such as eucalyptus are preferred because they shatter more slowly when their compressive strength is exceeded and give a cracking sound that warns miners. Soft woods such as cypress possess great elasticity but do not have the strength to resist great pressures. Hardwood timbers such as oak are strongly resistant to pressure but do not offer any elasticity and would break after very little bending.

6.3.2 It shall be strong enough to bend without breaking so that it gives miners warning of an approaching fall.

6.3.3 In selecting the size of timber, sizes shall be adjusted by taking into consideration the rock conditions, size and intended life of the opening and the type of timber to be used.

6.3.4 When blockings are used, they shall not be less than 30cm thick and shall consist of several pieces of blocks, planks, and wedges.

6.3.5 Footboards shall not be less than 50 mm thick, 250 mm wide and 900 mm long when stulls are installed in loose ground.

NOTE Timber is 4 to 5 times stronger when force is exerted parallel to the grain than when it is exerted perpendicular to the grain.

6.4 Timber preparation

6.4.1 After harvesting, timbers shall be stripped of the bark, seasoned, treated and allowed to dry. Timbers shall have a maximum moisture content of 19%.

6.4.2 Timber shall be treated to prevent decay.

NOTE Timber decay is usually accelerated by humid conditions in underground. Treatment is more effective if carried out on green timber and shall be carried out for 24 h – 56 h or longer (for dipping treatment).

6.4.3 Adequate ventilation shall be provided to improve drying effect and increase in strength of the installed pieces.

NOTE Ventilation is important to reduce timber decay.

6.4.4 When choosing timber members for underground support, the following shall be considered:

a) effective life of the opening and that of timber shall be coordinated, i.e., long life openings like adits/tunnels shall be supported by mature and well dried pieces;

b) installed timber members readily indicate an increasing load (from physical appearance), which provides ample time for installing additional support;and

c) settling or disturbance of supports due to failure of component parts, is usually local in character – confined to only a few sets at most.

6.5 Timber treatment

6.5.1 Humid conditions in a mine tend to promote timber decay; treatment of timber can slow down or even prevent decay.

6.5.2 Timbers shall be stripped of its bark and framed before treatment.

6.5.3 Treatment shall be carried out either by dipping or soaking the timbers in a tank or by using a pressure vacuum plant.

6.5.4 If available in the neighbourhood, treated timber can also be obtained from a commercial treatment plant.

6.5.5 Treatment by dipping or soaking shall follow the following procedure:

a) use a rectangular, welded steel tank (or equivalent): 1.2 m x 1.2 m x 4.8 m;

b) treat the timber while fresh and after stripping off its back and framing;

c) treatment time shall be between 24 – 56 h – the longer the better;

d) stark treated timber so that circulation of air is retarded to prevent rapid drying or seasoning;

6.5.6 If the treated surface shall be sawed of chopped when it is place underground, the freshly exposed wood shall be well painted with preserving solution.

6.5.7 Testing of treated timbers shall be performed in accordance with RS EAS 325.

6.5.8 Care shall be taken when handling and transporting treated timber to avoid excessive rupture of the treated surface.

6.5.9 The economic benefits of using treated timber are generally high especially when the installation is semi-permanent or permanent.

6.5.10 However, in many stopes and their accessories (drifts, crosscuts, raises) long life is not necessary and hence the use of treated timber might not be necessary.

6.5.11 The life of timber and the life of workings (excavations) shall be carefully coordinated.

6.6 Preparation for support

6.6.1 Support when required shall be done early and safe working procedures shall be followed. In areas with weak conditions, preparations shall be done to provide a safe working environment immediately.

6.6.2 Obtain information or a plan on the type of support and area to support the area shall be checked for preliminary requirements, such as slyping, installing of survey reference points, marking of grade and centre lines close to the area.

6.6.3 If required, prepare special foundation such as a concrete base for each timber set. Preparations of this nature shall be done in advance. The concrete base shall be in accordance with ISO 23872.

6.7 Installation of timber sets

The timber sets shall be installed centrally to the excavation on direction and grade.

6.7.1 Preliminary work

6.7.1.1 Lash and clean to footwall.

6.7.1.2 Transport materials and tools to work site.

6.7.1.3 Bar and wash down, install prop support and as head cover for protection.

6.7.1.4 Establish the centre and grade lines.

6.7.2 Erecting the timber set

6.7.2.1 Lash to solid rock footwall and/or level off where necessary, if foundation is not laid in advance. Where intervals between sets are pre-determined, the leg position can be made ready well in advance of installation.

6.7.2.2 **Set legs** - Cut the two legs from round poles, 225 mm x 225 mm or 200 mm x 100 mm timbers. For the square timber set, these shall be cut squarely at the top.; the three-piece drive set timbers shall be cut 5 degrees off square on both ends so that the legs shall lean in wards at 85 degrees on erection, in order to oppose the buckling effect.

6.7.2.3 Position the two legs on either side, measuring from the centre line. To maintain the legs in an upright position temporary, nail 200 mm x 50 mm timbers on the outer side, align them centrally and secure in the footwall.

6.7.2.4 **Cap** - Measure, cut and lift cap and fit into position on top of the legs squarely. Sprag on to the sidewalls using blocks with minimum wedges.

6.7.2.5 Spreader and studdle - With timber-mans` staff measure the distance between the legs at the top just below the cap. Cut 200 mm x 50 mm timber to required length and nail under the studdle (divider) timbers vertically across the joint between the legs and cap.

6.7.2.6 **Sill** - Measure the distance between the legs at footwall position. Cut 200 mm x 50 mm timber and nail across from one leg to another as sill timber [most applicable where there is no plinth foundation].

6.7.2.7 **Spacers** - Measure 1.8 m centre-to-centre for the next set. Erect second set in similar way as the first. Nail 200 mm x 50 mm timbers from one leg to the other on either side, at 0.6 m from footwall and 0.3 m from the cap as spacers. Spacers are to cover only half the width of the leg in order to leave space for the next spacer.

6.7.2.8 **Cribbing and top lagging** - On top of the cap, directly above each leg, run 200 mm x 100 mm timbers from cap to cap, and place similar timbers at 0.5 m intervals across the span. These form the first row of cribbing timbers. Between the cribbing timbers, place 200 mm x 50 mm timbers extended from cap to cap as top lagging. A gap of up to 100 mm can be maintained between timbers for bleeding purposes.

6.7.2.9 **Side lagging** - Install 200 mm x 50 mm side lagging timbers by nailing these onto the legs on the outer sides. Gaps of about 0.3 m shall be maintained between side laggings for bleeding purposes.

6.7.2.10 **Additional cribbing** - The next row of cribbing timbers are placed across the bottom row, ie running from one side wall to the other, maintained at similar intervals of 0.5 m.

6.7.2.11 **Pony set** - If the ground has peeled off upwards across the span of the excavation in excess of 1.2m above the timber set cap, a pony set is installed. Legs of 0.5m length are cut 5 degrees off square on both ends. These are installed on top of the cribbing timbers, with cap and further cribbing until the hanging wall is reached.

6.7.2.12 **False caps** - If the ground is peeled off asymmetrically upwards in excess of 0.5 m above the timber set cap, a false cap is installed.

6.7.2.13 Caps are installed over the first set in a normal way. On the side where ground is peeled to the highest point, with two or more blocks placed over the cap directly above the position of the leg.

6.7.2.14 The false cap is then installed to rest on the blocks on one side, and on top of the cap on the lower hanging wall side.

6.7.2.15 After two consolidated sets, sill timbers and temporary support timbers can be removed.

6.7.2.16 Only hardwood wedges shall be used and a minimum of two of them. All wedges shall be installed to last as long as the whole set lasts.

6.7.3 Timber pack support standard

6.7.3.1 Scope of timber packs supports offer passive support

The pack shall withstand compression from either elastic convergence or the dead weight of separated strata or fractured rock block.

6.7.3.2 Effectiveness of timber pack

Stiffness is required for a timber pack to give maximum support.

6.7.3.3 Purpose and application of timber packs

Timber packs shall be constructed as pillars in shallow dipping drives for the purpose of controlling strata separation, loosening of fractured rock and hanging wall surging.

6.7.3.4 Timber pack support requirements

6.7.3.4.1 Slab timbers, 225mm x 225mm, 200mm x 100mm timber, round poles, hardwood wedges and normal timbermans` hand tools.

6.7.3.4.2 Area shall be wide enough with a regular footwall. The wider the area the better as compared to height.

6.7.3.4.3 Water increases creep in timber, therefore, timber packs do better in dry conditions. Denser timbers are less susceptible to creep because of their strength and less moisture absorption

6.7.3.4.4 **Fill material** - Sorted competent waste rock shall be used.

6.7.3.5 Timber pack preparation

6.7.3.5.1 Lash to footwall and level off.

6.7.3.5.2 Bar and wash down and make safe.

6.7.3.5.3 Transport all materials to site.

6.7.3.5.4 For composite timber packs, concrete brick mats are to be made in advance.

6.7.3.5.5 For timber mat packs, the mats are threaded in advance with iron bars.

6.7.3.6 Construction of timber pack

6.7.3.6.1 Prop up and wedge two up right side lagging timbers on the down dip edge of the support area if the footwall has a gradient of more than 5 degrees. If the footwall is flat, no up right side lagging is required.

6.7.3.6.2 Lay first base timber against the up rights, to extend across the support area up to side wall. Lay second base timber 0.3 m away from first timber up dip.

6.7.3.6.3 Place first deck timber to rest on footwall at extreme up dip end and on top of the first two base timbers on the down dip side. More second base timber up and down dip until decking timber stabilises.

6.7.3.6.4 Place other decking timbers towards side wall, maintaining 0.3 m between them.

6.7.3.6.5 Fill up spaces between base and decking timbers to level of first decking with clean sorted waste rock as fill material.

6.7.3.6.6 Place next decking timbers across the first decking. Each timber shall be cut to extend from limiting edge of the timber pack to the rock face on the side wall, with 0.3 m intervals maintained.

6.7.3.6.7 Fill up second decking level with fill material.

6.7.3.6.8 Continue decking, positioning each decking timber in the same position as preceding decking timbers of similar direction.

6.7.3.6.9 Build timber pack to hanging wall. Block and wedge against hanging.

6.7.3.7 Other support – Steel archs

6.7.3.7.1 In hard rock mining, limited application since most support duties can be performed more effectively by rock bolts, dowels or shotcrete or by some combination of these systems.

6.7.3.7.2 Where used in mining through faults or in very badly broken ground associated with faults of shear zones. In such cases, it may be impossible to anchor the rock bolts or dowels in the rock mass and steel sets may be required.

6.7.3.7.3 Application in small scale mining is limited due to cost compared to timber.

6.7.3.8 Other support - Roof bolting

6.7.3.8.1 Rock conditions shall determine the type of rock bolting support The method shall be used where the ground condition requires the rock formation either to be reinforced and form part of the reinforced rock mass

6.7.3.8.2 Use of Grouted re-bars and wire dowels is the most common method of rock bolting support.

6.7.3.8.1 Minimum requirements for roof bolting installation

6.7.3.8.2.1 Drilling equipment, pedal pump for grouting and accessories.

6.7.3.8.2.2 200 mm x 100 mm timbers for prop support.

6.7.3.8.2.3 Safety goggles, nose/mouth cloth respirators, water proof suits.

6.7.3.8.2.4 Wire dowels or rebars of the appropriate sizes; 1.5 m, 1.8 m, 2.1 m or 2.4 m.

6.7.3.8.2.5 Pockets of cement, a 210 - litre drum cut into two portions, sieve (< 5 mm mesh), mixing puddle or stirring stick, cotton or waste paper, 5 - litre bucket.

6.7.3.8.2.6 Drilling pattern and method established.

6.7.3.9 Procedures on timber support inspections and maintenance

The Manager shall specifically appoint person who shall examine all haulages and traveling ways once a week and enters the results of the examination in a special log book. The examination shall include:

a) quality of the timber setts;

b) any noticeable movement on the sets; and

c) new areas requiring support.

6.7.3.10 Illustration of a square timber set

6.7.3.10.1 Figure 6 gives a typical illustration of a square timber set.

6.7.3.10.2 When concrete or steel structures are used, they shall meet requirements of ISO 23872.

Support illustration

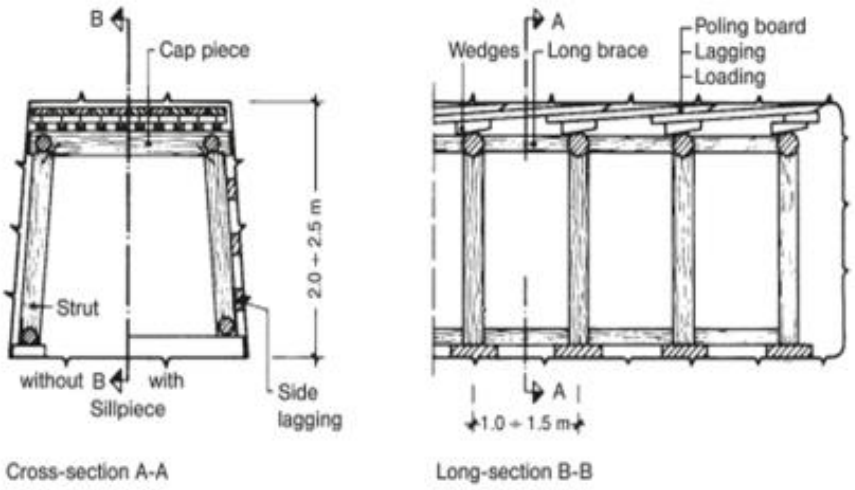

Figure 1— An example of timber set

6.7.4 Safety crown pillars to be set

6.7.4.1 Safety (crown) pillars shall be set out and defined at every mining operation taking in consideration the geological conditions of the rocks.

6.7.4.2 The Mining technician shall ensure that a safety crown pillar of reasonable thickness is provided to prevent collapse of the roof in the following situations:

a) pillar above the first horizontal tunnel off the shaft taking;

b) pillars defining the distance between two horizontal drives, tunnels or sublevels; and

c) pillar above the adit drive.

6.8 Types of ladders used in underground mines

6.8.1 General

6.8.1.1 There are three types of ladders that are commonly used in underground mining:

a) ladder with wooden rungs that is commonly used in shafts and raises;

b) ladder with iron pipe rungs that is commonly used in shafts; andladder made of iron chain commonly used during sinking vertical shafts and raises and that is usually 5 m – 6 m long and is hung from the last set of shaft/raise timbers and extends to the bottom of the shaft/raise.

6.8.1.2 Sometimes in prospecting shafts, a rope ladder may be used, but the iron chain ladder, while heavier than the rope ladder, shall last longer and is safer, as it is not easily damaged by blasting.

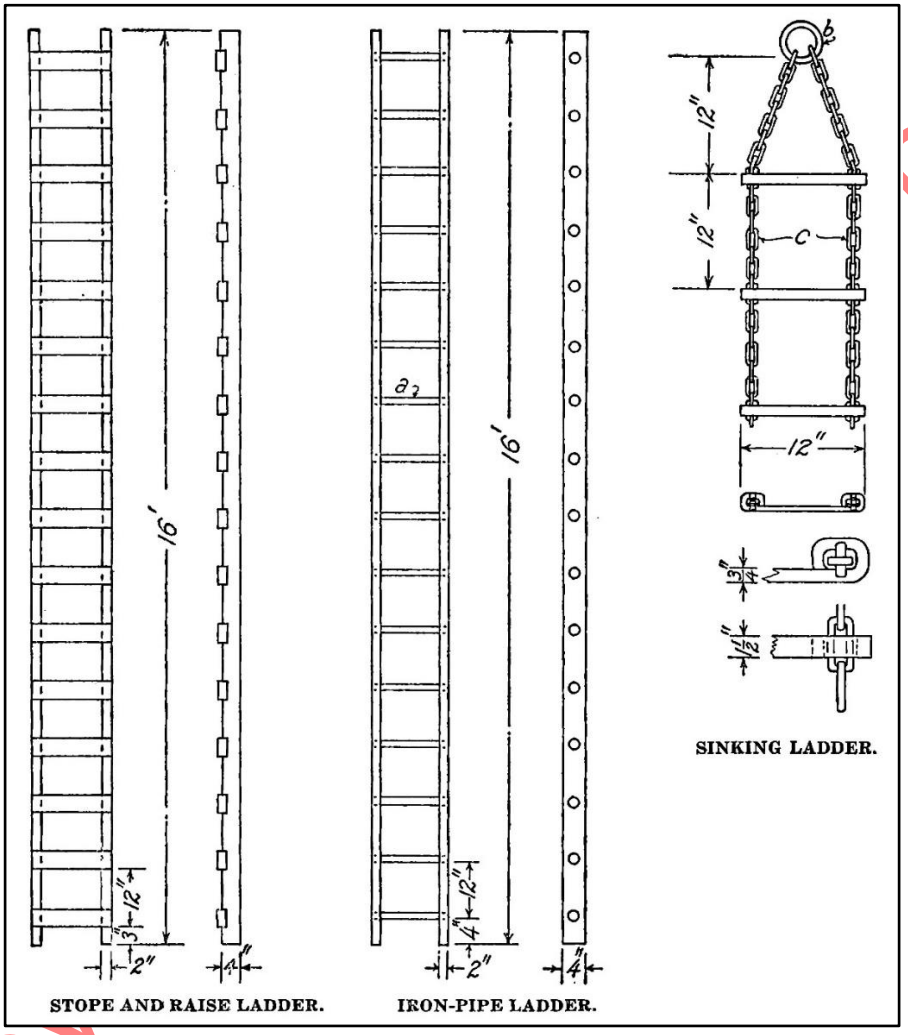

Figure 2 — Type of Ladders used in underground mining

6.8.2 Ladderway in the mine

6.8.2.1 The manager of an underground mine shall ensure that in each underground workplace in the mine a proper ladderway or footway or other means of travel is provided that enables safe entry and exit.

6.8.2.2 There shall be provided a sufficient number of ladder ways and traveling ways permanently maintained and kept free from obstruction to enable every person to leave every part of a mine.

6.8.2.3 Any shaft or raise at an inclination of more than forty-five degrees (45^0) above the horizontal or any winze at an inclination of more than forty-five degrees (45^0) below the horizontal, through which persons travel, or at any shaft, winze, or raise having mechanical haulage and through which persons travel, shall have a separate ladderway compartment.

6.8.2.4 There shall be adequate clearance from pipes, cables, or other services for people using ladderways. Appropriate measures shall be taken to ensure that no material can be dropped down any ladderway. No material should be raised or lowered in the ladderway while any person is using it. Both hands shall be free when climbing or descending on ladders. Any load slung on the back and shoulders shall be secured safely, and not be of such bulk or weight as to present a risk of falling, where a ladderway is equipped with a slide for landing materials with a winch or by a hand rope, no person may travel in the ladderway during the haulage of material.

6.8.2.5 Every ladderway shall afford a safe means of entering and exiting at any sublevel to which it gives access, as well as the top and bottom entry. Access ladderways to stopes shall also have protection or a covering, readily removable for the transfer of equipment, to prevent people working in the stope from falling into the ladderway.

6.8.2.6 Dry, slip-free, surfaces are important when using a ladder. Therefore, ensure that your hands and shoes are dry as well as the ladder rungs. Do not use sandals, flip-flops, or similar loose-fitting footwear. Do not paint a ladder as this can possibly result in it becoming more slippery.

6.8.2.7 The manager of an underground mine shall ensure that if a ladderway at the mine may be used as a means of providing access for mine rescue, the opening of the ladderway is wide enough to be used for that purpose.

6.8.2.8 **T**he following pre-use checks shall be performed:

a) the stiles – make sure they are not bent or damaged, as the ladder could buckle or collapse;

b) the feet – if they are missing, worn, or damaged the ladder could slip;

c) the rungs – if they are bent, worn, missing, or loose, the ladder could fail;

d) the locking mechanism – does the mechanism work properly; and

e) always check the extension locks to make sure they are properly seated.

6.8.3 Ladderway in shaft

The mine manager shall ensure that each ladder in the mine that is constructed and fixed in a shaft for the ascent and descent of persons working in the mine and the following shall ensure that:

a) if is not projected vertically, the distance between the wall and the base of your ladder should be one-quarter of the ladder's height (putting the ladder at a 75° angle);

b) when the ladder is projected vertically, shall provide a minimum of 150mm of the clear distance between the ladder rungs (centrelines) and the walls, this 150mm minimum stand-off clearance protects the person

climbing the ladder from likely trip hazards that would exist with less free space between the ladder and walls;

c) ladder rungs, steps, and cleats shall have a minimum clear width of 40 cm;

d) rungs, cleats, and steps of ladders must be spaced not less than 25 cm apart, nor more 36 cm apart, as measured between centreer lines of the rungs, cleats and steps;

e) the ladder shall have substantial platforms at intervals of not more than 4 meters for wooden ladders and 10m for fiberglass or metal (aluminium) ladders, the platform shall not be less than 60 cm of width to 1 m of length;

f) extended ladder at 1m high above the access level or landing platform at the top of the ladder; and

g) ladder in shaft projects at least 600 millimetres above the platform or, if that is not practicable, has hand grips provided at the top of each ladder.

7 Mine ventilation

7.1 General

7.1.1 The mine operator shall excavate secondary shafts or egress for the purpose of ventilation.

NOTE Secondary shafts allow air to naturally ventilate the working areas to facilitate an effective and sufficient natural pressure gradient.

7.1.2 Where more than one secondary shafts are excavated, they should be located on different elevations where applicable.

7.1.3 No mine worker shall enter any work place underground, in particular those places with poor air circulation, unless the air has been checked therein to ensure a safe breathable atmosphere free from levels of hazardous gases.

7.1.4 The Manager shall ensure that adequate and effective ventilation is supplied to all places in a mine where persons are working or travelling.

7.1.5 Consequences of poor ventilation may, among others, be:

a) heat exhaustion where temperatures are excessive;

b) exposure to blasting fumes, which can lead to unconsciousness and even death;

c) exposure to excessive levels of diesel particulates, which can lead to occupational health issues such as lung damage; and

d) increased exposure to risk when fatigue results from a poor working environment can lead to fatality due to lack of adequate oxygen.

7.2 Ventilation planning process

7.2.1 Ventilation system shall be able to supply a quantity of oxygen for breathing purposes at minimum of 19.5 % by volume.

7.2.2 The ventilation system shall remove heat and provide comfortable working conditions and hence improve production.

7.2.3 The ventilation system shall dilute and remove noxious and flammable gases that may be encountered during mining operations.

7.2.4 The ventilation system shall dilute and remove hazardous airborne pollutants created by various mining operations underground (e.g.: dust, fumes, aerosols, vapours, etc.).

7.3 Quantity of oxygen required in mines

The air in areas where persons work or travel in mines shall contain at least 19.5 % oxygen and not more than 0.5 % carbon dioxide. Table 1 indicates effects of reduced oxygen supply.

Table 1 — Effects of reduced oxygen supply

Oxygen in air (%)	Effects
19	Flame height on a lamp or candle reduced by 50%
17	Noticeable increase in rate and depth of breathing – this effect shall be further enhanced by an increased concentration of carbon dioxide
16	Flame on a lamp or candle extinguishes
15	Dizziness, increased heartbeat
13-9	Disorientation, fainting, nausea, headache, blue lips, coma
7	Coma, convulsion and probable death
Below 6	Fatal

7.4 Location of fans

7.4.1 A ventilation system for fan locations and airflow direction shall be one of the following:

a) exhaust (pull) system, mine fan shall be located on top of return airshaft;

b) blowing (push) system, mine fan shall be installed at the intake airshaft; and

c) combined system (push-pull), fans shall be installed on the intake and return airshafts.

7.5 Ventilation for development ends

7.5.1 The shall be established crew of pipe laying personnel who shall work under a competent person for safe laying and maintenance of ventilation pipes.

7.5.2 As the development ends are worked, the pipe laying crew shall ensure that pipes are extended and ready for the drilling crew in advance in order to:

a) ventilate;

b) extend compressed air to the drill face; and

c) extend water lines, to the drill face.

7.5.3 The fans shall be used to ventilate the development drives drill faces.

7.5.4 The recommended sizes of fans and ventilation pipes/tents shall depend on the size of openings of headings.

7.5.5 Typical ventilation quantities in small mine head with fan sizes is given in Table 2.

Table 2 — Fan size and air delivery in different headings

Fan Size	Air Quantity (Cubic metres per sec)	Where fan is used
380 mm	1.6	Small heading
405 mm	1.7	Small heading
480mm	3.3	Service drift

7.5.6 Mine layout shall illustrate the ventilation system and shall be demonstrated near the tunnel or other underground openings entrance.

7.5.7 A ventilation fan shall be installed on the surface. When installing a ventilation system, the following shall be considered:

d) the side of the ventilator that draws in air must be open and free from any blockages or impediments from other objects;

e) the ventilation fan must be protected by metal mesh;

f) the ventilation pipe must be safe and whole.

7.5.8 Flow velocity in all accessible and ventilated underground openings shall be greater than 10 m/min (> 0.15 m/s).

7.5.9 If diesel powered equipment is used, an air flowrate shall be 2,8 – 3,8 m^3/min per Kw. These conditions have to be satisfied for the whole range or area where the diesel equipment is working.

NOTE Airflow direction is affected by the location of the main fan which, in turn, impacts the other mine operations.

7.5.10 In order to monitor ventilation fans, the following shall be performed:

a) in long underground excavations where there is poor ventilation, fans shall be installed underground to produce the required airflow to the working ends;

b) the fans shall be powered by means of a compressor or electricity;

c) to assure electrical and mechanical reliability of main mine fans, each of the compressors and the main mine fan and its associated components, shall be examined for proper operation by a trained person;

d) fans and compressor monitoring system shall be examined at every mine prior to anyone entering the mine. A log book shall be filled in accordance with Annex C;

e) assess fan capacity to deliver air to all working ends;

f) monitor and implement development of return air drives;

g) adhere to re-entry procedures in mines with blasting; and

h) make shift supervisors aware of the ventilation standards in their operating areas.

7.5.1 Prohibition of actions affecting ventilation in underground environments

7.5.1.1 The use of machinery, water pumps that would produce toxic gases shall not be allowed.

7.5.1.2 Unless in wide workings with adequate ventilation, monitoring of gases shall be periodic and documented. Annex A gives permissible limits of certain gases.

7.5.1.3 Machinery shall comply with emission requirements in accordance with RS 407-2.

7.5.1.4 Diesel fumes shall not be permitted in underground mines.

7.5.1.5 Use of candles shall not be permitted in underground mines

7.5.1.6 Use of substances producing toxic gases, fire, burning and any other flammable materials are not permitted in underground mines.

7.5.2 Requirements for installing a ventilation system

7.5.2.1 For natural ventilation systems, the shaft entrance points shall be at two different levels. If it is not possible to meet this requirement due to the characteristics of the area, use a regular pipe to differentiate between the levels of the shaft collars.

7.5.2.2 Fans are used for artificial ventilation systems. A pipe transferring air shall be made of a wind-proof material. In order to transfer air over a long distance, the pipe shall be straight and whole, without any holes or breaks.

7.6 Monitoring of O_2 levels in mines

10.6.1 Each mine site shall monitor levels of air quality especially in underground mines using calibrated equipment.

10.6.2 The records of O_2 monitoring shall be documented.

7.7 Instructions on pipe laying for water and air

The following instructions shall be followed while laying pipes for water and air:

a) pipe laying for water and air shall be in accordance with applicable standards;

b) installation work shall be carried out by personnel who have received the necessary training, where:

1) only approved clamps shall be used during pipe installation. All clamps shall be carefully examined before installation, i.e.: for cracking;

2) at every material crosscut an air-line of required diameter (e.g.: 150 mm) and a diameter water line of required set diameter (100 mm) shall be laid from the Haulage pipe line. The air-line shall in all cases be carried on top and the water line below;

3) service holes shall be drilled such that every pipe is supported at each end, that is, two holes per pipe;

4) each shall be equipped with either an appropriate eyebolt or J-hook which shall be firmly anchored;

5) the support eyebolt holes shall not be less than 0.2 m in depth; and

6) main air and water valves and an air pressure gauge shall be installed to specifications on the pipes.

8 Air compressors and underground lighting

8.1 Air compressors underground

Any compressor which compresses air, used underground in a mine, shall be designed, constructed, operated, regularly tested and maintained for the following reasons:

a) air entering the compressor is not contaminated by pollutants and is as dry, clean and cool as practicable;

b) only high-quality mineral oil or suitable synthetic oil, having a specified flashpoint, shall be used for lubricating the compressor;

c) services shall be supported from properly secured fastenings, which shall not be used for any other purpose, and the number of fastenings shall be adequate;

d) services hung in haulage and travel ways (including ladder ways) shall be installed in such a manner to provide for adequate clearance for persons and equipment;

e) pipelines shall be connected by approved couplings; and

f) no repairs shall be carried out while any service is under pressure.

8.2 Underground lighting

8.2.1 Every mine shall provide suitable fixed lighting to employees involved in working in underground work with cap lamps or torch light. The serviceability of the lighting devices shall be verified by the mine operator.

8.2.2 The mine responsible person shall ensure personal lighting for underground use are in place.

8.2.3 Workers shall only take fully charged batteries.

8.2.4 Lamps shall be maintained regularly.

8.2.5 Cap lamps globes shall be checked for correct operation before proceeding underground.

8.2.6 Cap lamps shall not be taken into mines unless they are fully functional and secure.

8.2.7 The cap lamps or torch light shall be in a condition to illuminate the workings with a minimum luminous efficacy of 60 lm/w and the batteries shall have longevity to last a minimum of 8 h.

8.3 Safe use of electricity

8.3.1 Where electricity is used in mine workings, the mine operator shall ensure that a competent person is appointed to be responsible for all the electrical installations and operations and shall ensure that proper electrical signage is put in place. Updated electrical plans identifying and showing the location of all of the electrical installations at the mine including underground installations should be provided at the mining site. The information regarding the electrical safety data including the equipment ratings and other protection settings for circuit protection devices should be provided and updated.

8.3.2 All electrically operated equipment shall be selected, arranged, installed, protected, maintained and operated in such a manner as to prevent danger.

8.3.3 The mine's electrical distribution system should be independent and have switchgear systems to control circuit interruptions under fault conditions.

8.3.3.1 The mine's electrical circuits should be protected against overload, short circuit faults, and earth faults. The protective means for protecting overvoltage and strikes from lightning should be in place. Surge and lightning arrestors should be installed in the mining installation sites.

8.3.3.2 The electrical operator shall insure that the mine's installation earthing system is installed and maintained at very low impedance to ensure reliable operation of electrical protective systems and devices. The conductive parts of electrical equipment at the mining site shall be earthed to ensure adequate protection.

8.3.4 To every electrical circuit, effective means, suitably placed for isolating the supply of electricity from the circuit shall be provided to prevent danger.

8.3.4.1 The emergency stopping systems and safety alarms shall be installed at the mine site and they shall be effective in case there are electrical faults and failures.

8.3.5 Effective automatic means of preventing the energising of any electrical circuit or electrical apparatus shall be provided to prevent danger.

8.3.6 Every electricity generating plant and all substation equipment shall be adequately fenced or enclosed and notices prohibiting unauthorised persons from entering shall be placed.

8.3.7 No inflammable or explosive materials shall be placed in dangerously near to any electrical apparatus.

8.3.8 Only competent personnel shall be permitted to carry out work on explosive electrical equipment.

NOTE Examples of explosive electrical equipment include detonators and compressors.

8.3.9 All material used for the purpose of insulating any conductor shall be suitable and shall have required degree of insulation and mechanical strength required.

8.3.10 Communication shall be made to all staff at site in case of electricity disconnection, connection and maintenance activities being carried out on the mining site.

NOTE The communication can be verbal, emails, notice, etc. The communication should be documented as far as possible.

Annex A
(normative)

Maximum permitted quantities of certain gases

Description of gas	Maximum permitted quantity of gas in parts per million
1.Carbon dioxide	7 500
2.Carbon monoxide	100
3.Nitrous fumes	10
4.Sulphur dioxide	20
5.Hydrogen sulphide	20

Annex B
(normative)

Daily logbook for examinations to be carried out in underground mine working areas prior to access

Table B.1 — Daily logbook of underground/surface mine access

Company Name:

Tunnel/Adit/Shaft Name: Mine site name:

Starting date…….. Ending date ……

No		Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Sunday	
		D/S	N/S	D/S	N/S	D/S	N/S	D/S	N/S	D/S	D/S	D/S	N/S	D/S	N/S
1.	All Access and egress are in good condition?														
2	Do all employees wear PPE?														
3	Are there any hanging walls?														
4	Are gravitational sources such as roofs, backs, sides, floor and walls in good condition?														
5.	Are ventilation units in good condition?														

6.	Oxygen is sufficient in all underground openings and no dust?														
7.	Is the lighting and supply system in good condition?														
8	Is the installed underground support system in good condition?														
9	Gases such as H2S, CO, CO2 NOx have been checked?														
10	Equipment and tools used today are in good condition?														
11	Ladders are in good condition?														
11	Other findings,…														
	Is it permitted for workers to enter?														
	Day Team Leader (Name and Signature)														
	Evening shift Team Leader (name and Signature)														
	Day comments														

	Evening comments														
	Supervisor (name and Signature and comment.														

D/S: Day Shift, N/S: Night shift

Annex C
(normative)

Daily logbook of ventilation fans

Table C.1 — Daily log book of ventilation fans/compressors

Company Name:

Mine site Name: Tunnel/Adit/Shaft Name:

Serial Number of Fan/Compressor ……,

From……/……/……..
to……../……/……

No	**Are the following symptoms observed during day work?**	**Monday**		**Tuesday**		**Wednesday**		**Thursday**		**Friday**		**Saturday**		**Sunday**	
		D/S	N/S	D/S	N/S	D/S	N/S	D/S	N/S	D/S	D/S	D/S	N/S	D/S	N/S

1.	Too much noise														
2	Fairly to start														
3	Fan/compressor operating too hot														
4.	Decreased discharge airflow rate.														
5.	Other symptoms														
6.	Is it permitted to use assessed equipment?														
7	If no Suggested maintenance and any comment.														
	Assessor name:										**Signature**				

DS: Day Shift, NS: Night Shift

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