



DRAFT TANZANIA STANDARD

Ventilation in underground mines - Part 1: Air quality requirements

Draft Standard for Stakeholders' comments

TANZANIA BUREAU OF STANDARDS

0 Foreword

This draft Tanzania Standard is being prepared by the Mine Planning Operations and Services Technical Committee (MMDC 2) under the supervision of Mining and Minerals Standards Divisional Committee (MMDC).

Currently, this draft Tanzania Standard consists of two parts as shown in the bullets below, under the general title “Ventilation in underground mines”;

- Part 1: Air quality requirement
- Part 2: General guideline

Other parts of the standard may be developed later if the needs arise.

In preparation of this draft Tanzania standard assistance was derived from the following documents;

- Ventilation in underground mines and tunnels – Approved code of practice of 2014 developed by WorkSafe New Zealand,
- U.S. Code of federal regulations - Title 30 Mineral Resources published in 2018 by Office of the Federal Register

1 Introduction

Mine Ventilation refers to supply of fresh air and removal of the diluted air/polluted air out of the mine, it can be supplied in mine and removed either naturally or artificially. The need of supply of air provides oxygen to personnel and equipment to ensure the safety of lives of people working in underground mine. Besides, supply of air dilutes toxic gases, dusts and emission resulting from production and control humidity and temperature. Therefore, the concentration limits for exposure of people and equipment have to be set for different type of mines including those mining coal and metalliferous. Pollutants of air in underground mines include dust and a combination of many other potential hazards, such as toxic or flammable gases, heat, humidity, and radiation. It is important to enhance employee safety, comfort, health, and morale in order to ensure effective working. This can be attained by making sure that the contaminants are not allowed to exceed mandatory threshold limits imposed by standards and regulations.

Coal mines and metalliferous mine have different levels of contaminants allowed for exposures of mine workers and equipment. The contaminants vary from one mine to the other based on size of the mine, number of workers and machines working in the mine, temperature and level of emissions.

2 Scope

The Tanzania Standard gives requirements including specifications of acceptable quality of air in underground mines. The requirements are established with the aim of protecting health and safety of personnel working in underground mining environment. This standard gives air quality requirements for both coal and non-coal underground mines. The contents of this Tanzania standard shall not apply to tunneling in the construction industry.

3 Normative references

The following standards are referred to in the text in such a way that some or all of their content constitutes requirements of this document;

- TZS 2074 – 4 Glossary of mining terms – part 4: Ventilation
- TZS 845 Air Quality – specifications

4 Terms and definitions

For the purpose of this standard the definitions contained in TZS Glossary of mining terms – part 4: Ventilation shall apply. Also, the following definition shall apply for the term below;

4.1 Working face – the place at which mining is being done in a heading, drift, adit, airway, chute, crosscut, etc.

4.2 Longwall working face – a working face in the mine in which flat-bedded deposits are mined through advancing over a considerable width at one time

4.3 Wet bulb temperature - the temperature read by a thermometer covered in water-soaked cloth (wet-bulb thermometer) over which air is passed.

5 General requirements

5.1 Exposure limits for airborne contaminants.

Except as provided below, the exposure to airborne contaminants shall not exceed, on the basis of a time weighted average, the threshold limit values stated in Tzs 845.

Fresh air contains the following gases at the lowest practicable level and at no more than the following levels

Table1: Time-weighted average exposure (ppm) Short-term exposure limit (ppm)

Pollutants	Time-weighted average exposure	Maximum allowable	Short-term exposure limit
Carbon dioxide	5000	5000	30000
Carbon monoxide	50	100	300
Hydrogen sulphide	10	20	15
Nitrogen dioxide (NO ₂)	3	5	5
Nitric oxide (NO)	25	25	35
Nitrous oxide (N ₂ O)	100	25	
Sulphur dioxide	2	10	5
Ammonia (NH ₃)	25	50	35
Methane (CH ₄)		10000	
Asbestos (fibres/milliliter hour) per	0.1	2	

Where:

Time-weighted average exposure is calculated as follows:

Total exposure in day (concentration x time)

8 hours

Short-term exposure limit means the average exposure measured over any 15-minute period in the working day.

5.2 Quantity and velocity of air

The mine manager must ensure that an adequate quantity and velocity of air is delivered to the working face of any production or development place, and within the roadways leading to any working face, workshops, shaft stations, magazines and other underground areas where personnel can be found to dilute and render harmless any accumulations or layering of airborne contaminants.

The volume of air passing through an active working face, other than a longwall working face, is not less than 0.3 cubic metres per second for each square metre of normal development cross-sectional area and

the volume of air passing through an active longwall working face is not less than 4 cubic metres per second for each metre of extracted height in the face.

The mine manager must ensure, in respect of any underground parts of a mining operation where a mine worker is doing work or may travel, that the air in that part is provided at an adequate quantity and velocity to ensure the mine worker will not be exposed to a concentration of dust that is likely to cause harm to the mine worker.

5.3 Heat and humidity

The mine manager should ensure that the temperature, humidity and air velocity are controlled underground so that mine workers are not severely stressed by the exposure to extreme heat, humidity or cold. This includes the development of a program for the control of heat stress.

Intervention measures are required when the wet bulb temperature increases above 25°C. Some of the intervention measures are indicated in the Table 2.

Table 2: Intervention measures to be taken by the mine at certain temperature/humidity levels.

Temperature	Action
Wet bulb > 25°C	An air velocity of not less than 0.5 metres per second should be provided.
Effective Temperature >30°C	The mine manager should ensure mine workers do not work in the mine unless carrying out work in an emergency situation in accordance to Standard Operating Procedures.

The mine manager should ensure there is a procedure available at the mine or tunnel to determine the Effective Temperature.

5.4 Methane levels

5.4.1 Gas emissions

Gases released from the surrounding rock or other sources may be suffocating, toxic or explosive, and some may have both toxic and explosive properties.

Although the release of methane is not commonly experienced in metalliferous mines and tunnels, it can occur, and the mine manager should ensure that appropriate monitoring and control measures are in place for the early detection of such gases.

- a) If the level of methane exceeds 1% by volume, all non-safety critical electrical and diesel equipment in the place where the level is exceeded should be de-energized, shut down or switched off.
- b) Where the level of methane in the air is 2% or more by volume, all mine workers in that part of the mine should be withdrawn to the surface or a place of safety.
- c) Access to the affected area should be prevented with a secure barricade or fence that is clearly marked with danger tape and sign post written "DANGER - DO NOT ENTER" to prevent access.
- d) In a mine or tunnel where monitoring identifies that gas released from the surrounding rock is a risk, the mine manager should ensure that the Ventilation Control Plan includes control measures such as:
 - i. Sealing of the surrounding rock.
 - ii. Closure and sealing of the problem area of the mine.
 - iii. Draining off the gases to exhaust.
 - iv. Pressurizing the area to contain gases in the surrounding rock.
 - v. Dilution of gases to harmless levels by increased ventilation volumes.

- vi. Absorption by water percolation and spraying.
 - vii. Monitoring systems with appropriate alarms.
- e) In a mine or tunnel where gas being released from the surrounding rock is likely to occur, all mine workers should be trained in how to identify the hazard, the need to immediately report an occurrence, and procedures for the use of personal respiratory protection or refuge chambers, in the event that hazardous gas is identified as being released into the underground atmosphere.

6 Air quality requirements for underground metal and nonmetal mines

Mine manager shall ensure air in all active workings of an underground mine contain at least 19.5 volume percent oxygen.

6.1 Exposure limits for airborne contaminants.

The exposure to airborne contaminants shall not exceed, on the basis of a time weighted average, the limit values listed in the TZS 845: 2012

6.2 Exposure monitoring.

Mine manager should ensure dust, gas, mist, and fume surveys are conducted at least once per month to determine the adequacy of control measures.

6.3 Control of exposure to airborne contaminants.

Control of employee exposure to harmful airborne contaminants shall be, insofar as feasible, by prevention of contamination, removal by exhaust ventilation, or by dilution with uncontaminated air. However, where accepted, engineering control measures have not been developed or when necessary by the nature of work involved (for example, while establishing controls or occasional entry into hazardous atmospheres to perform maintenance or investigation), employees may work for reasonable periods of time in concentrations of airborne contaminants exceeding permissible levels if they are protected by appropriate respiratory protective equipment.

Whenever respiratory protective equipment is used a program for selection, maintenance, training, fitting, supervision, cleaning, and use shall meet the following minimum requirements:

- a) Approved respirators which are applicable and suitable for the purpose intended shall be furnished and miners shall use the protective equipment in accordance with training and instruction.
- b) A respirator program consistent with the requirements of ISO/TS 16975-1:2016
- c) When respiratory protection is used in atmospheres immediately harmful to life, the presence of at least one other person with backup equipment and rescue capability shall be required in the event of failure of the respiratory equipment.

6.4 Exposure to particulate matters

6.4.1 Respirable dust standard.

Each operator shall continuously maintain the average concentration of respirable dust in the mine atmosphere during each shift to which each miner in the active workings of each mine is exposed, as measured with an approved sampling device and expressed in terms of an equivalent concentration, at or Below 1.5 mg/m³.

6.4.2 Respirable dust standard when crystalline quartz is present.

- (a) Each operator shall continuously maintain the average concentration of respirable quartz dust in the mine atmosphere during each shift to which each miner in the active workings of each mine is exposed at or below 0.4 mg/m³ (400 micrograms per cubic meter or µg/m³) as measured with an approved sampling device and expressed in terms of an equivalent concentration.
- (b) When the equivalent concentration of respirable quartz dust exceeds 100 µg/m³, the operator shall continuously maintain the average concentration of respirable dust in the mine atmosphere during each shift to which each miner in the active workings is exposed as measured with an approved sampling device

and expressed in terms of an equivalent concentration at or below the applicable standard. The applicable standard is computed by dividing the percent of quartz into the number 10.

6.4.3 Respiratory equipment; respirable dust.

Approved Respiratory equipment shall be made available to all persons. Use of respirators shall not be substituted for environmental control measures in the active workings. Each operator shall maintain an adequate supply of respiratory equipment.

When required to make respirators available, the operator shall provide training prior to the miner's next scheduled work shift, unless the miner received training within the previous 12 months on the types of respirators made available. The training shall include: The care, fit, use, and limitations of each type of respirator.

An operator shall keep a record of the training at the mine site for 24 months after completion of the training. An operator may keep the record elsewhere if the record is immediately accessible from the mine site by electronic transmission.

6.4.4 Respiratory equipment; gas, dusts, fumes, or mists.

Approved Respiratory equipment shall be provided to persons exposed for short periods to inhalation hazards from gas, dusts, fumes, or mists. When the exposure is for prolonged periods, other measures to protect such persons or to reduce the hazard shall be taken.

6.4.5 Selection, fit, use, and maintenance of approved respirators.

In order to ensure the maximum amount of respiratory protection, approved respirators shall be selected, fitted, used, and maintained in accordance with Tanzania Standards.

6.5 Air quality detectors and measurement devices.

(a) Tests for methane shall be made by a qualified person with approved detectors that are maintained in permissible and proper operating condition and calibrated with a known methane-air mixture as frequent as required by mine manager. The records shall be kept in monthly basis.

(b) Tests for oxygen deficiency shall be made by a qualified person with oxygen detectors that are maintained in permissible and proper operating condition and that can detect 19.5 percent oxygen with an accuracy of ± 0.5 percent. The oxygen detectors shall be calibrated before measurement.

(c) Handheld devices that are used for measuring air velocity, carbon monoxide, oxides of nitrogen, and other gases shall be maintained in permissible and proper operating condition.

(d) Maintenance of instruments required by paragraphs (a) through (c) of this section shall be done by persons trained in such maintenance.

6.6 Prevention of gas explosion other than methane.

For the purpose of preventing explosions from gases other than methane, the following gases shall not be permitted to accumulate in excess of the concentrations listed below:

- (1) Carbon monoxide (CO)—2.5 percent
- (2) Hydrogen (H₂)—0.80 percent
- (3) Hydrogen sulfide (H₂S)—0.80 percent
- (4) Acetylene (C₂ H₂)—0.40 percent
- (5) Propane (C₃ H₈)—0.40 percent
- (6) MAPP (methyl-acetylene-propylene-propadiene)—0.30 percent

6.7 Restricted use of chemicals.

Chemical substances that can result into contamination of underground air shall not be used or stored except under conditions approved by relevant government regulatory authority.

6.8 Radiation

6.8.1 Radon daughter exposure monitoring.

- a) In all mines at least one sample shall be taken from exhaust mine air by a competent person to determine if concentrations of radon daughters are present.

If concentrations of radon daughters in excess of 0.1 work level (WL) are found in an exhaust air sample, thereafter—

- i. Where uranium is mined—radon daughter concentrations representative of worker's breathing zone shall be determined at least every two weeks at random times in all active working areas such as stopes, drift headings, travelways, haulageways, shops, stations, lunch rooms, magazines, and any other place or location where persons work, travel, or congregate. However, if concentrations of radon daughters are found in excess of 0.3 WL in an active working area, radon daughter concentrations thereafter shall be determined weekly in that working area until such time as the weekly determinations in that area have been 0.3 WL or less for 5 consecutive weeks.
 - ii. Where uranium is not mined— when radon daughter concentrations between 0.1 and 0.3 WL are found in an active working area, radon daughter concentration measurements representative of worker's breathing zone shall be determined at least every 3 months at random times until such time as the radon daughter concentrations in that area are below 0.1 WL, and annually thereafter. If concentrations of radon daughters are found in excess of 0.3 WL in an active working area radon daughter concentration thereafter shall be determined at least weekly in that working area until such time as the weekly determinations in that area has been 0.3 WL or less for 5 consecutive weeks.
- b) If concentrations of radon daughters less than 0.1 WL are found in an exhaust mine air sample, thereafter:
 - i. Where uranium is mined—at least one sample shall be taken in the exhaust mine air monthly.
 - ii. Where uranium is not mined—no further exhaust mine air sampling is required.
 - c) The sample date, locations, and results obtained under (a) and (b) above shall be recorded and retained at the mine site or nearest mine office for at least two years and shall be made available for inspection.

6.8.2 Annual exposure limits.

No person shall be permitted to receive an exposure in excess of 4 work level month (WLM) in any calendar year.

6.8.3 Maximum permissible concentration.

Persons shall not be exposed to air containing concentrations of radon daughters exceeding 1.0 WL in active workings.

6.8.4 Respirators.

In environments exceeding 1.0 WL, miners shall wear respirators approved for radon daughters

6.8.5 Posting of inactive workings.

Inactive workings in which radon daughter concentrations are above 1.0WL, shall be posted against unauthorized entry and designated by signs indicating them as areas in which approved respirators shall be worn.

6.8.6 Protection against radon gas.

Where radon daughter concentrations exceed 10 WL, respirator protection against radon gas shall be provided in addition to protection against radon daughters. Protection against radon gas shall be provided by supplied air devices or by face masks containing absorbent material capable of removing both the radon and its daughters.

6.8.7 Gamma radiation surveys.

(a) Gamma radiation surveys shall be conducted annually in all underground mines where radioactive ores are mined.

(b) Radiation measurements are in excess of 2.0 milliroentgens per hour in the working place, gamma radiation dosimeters shall be provided for all persons affected, and records of cumulative individual gamma radiation exposure shall be kept.

(c) Annual individual gamma radiation exposure shall not exceed 5 rems.

6.9 Diesel particulate matter

6.9.1 Limit on exposure to diesel particulate matter.

a miner's personal exposure to diesel particulate matter (DPM) in an underground mine must not exceed an average eight-hour equivalent full shift airborne concentration of 160 micrograms of total carbon per cubic meter of air ($160_{TC} \mu\text{g}/\text{m}^3$).

6.9.2 Fueling practices.

Diesel fuel used to power equipment in underground areas must not have a sulfur content greater than 50 ppm.

6.9.3 Miner training.

(a) Mine operators must provide annual training to all miners at a mine covered by this part who can reasonably be expected to be exposed to diesel emissions on that property. The training must include—

- i. The health risks associated with exposure to diesel particulate matter;
- ii. The methods used in the mine to control diesel particulate matter concentrations;
- iii. Identification of the personnel responsible for maintaining those controls; and
- iv. Actions miners must take to ensure the controls operate as intended.

(b) An operator must retain a record at the mine site of the training required by this section for one year after completion of the training.

6.9.4 Diesel particulate records.

Table 3 lists the records the operator must maintain and the duration for which particular records need to be retained.

Table 3: Diesel Particulate Matter Recordkeeping Requirements

Record	Retention time
1. Approved application for extension of time to comply with exposure limits.	Duration of extension
2. Identity of physician or other health care professional and most recent written determination of miner's ability to wear a respirator.	Duration of miner's employment plus 6 months
3. Purchase records noting sulfur content of diesel fuel.	1 year beyond date of purchase

4.	Maintenance log	1 year after date any equipment is tagged.
5.	Evidence of competence to perform maintenance.	1 year after date maintenance performed.
6.	Annual training provided to potentially exposed miners.	1 year beyond date training completed.
7.	Record of corrective action	Until the corrective action is completed.
8.	Sampling method used to effectively evaluate a miner's personal exposure, and sample results.	5 years from sample date.

7 Air quality requirements for underground coal mines

7.1 Airborne contaminants

7.1.1 Emission limits for permissible diesel-powered equipment.

Each piece of permissible diesel-powered equipment introduced into an underground area of an underground coal mine must emit no more than 2.5 grams per hour of diesel particulate matter.

7.1.2 Emission limits for nonpermissible heavy-duty diesel-powered equipment, generators and compressors.

Each piece of nonpermissible heavy-duty diesel-powered equipment generator or compressor in an underground area of an underground coal mine must emit no more than 2.5 grams per hour of diesel particulate matter.

Notwithstanding the other provisions of this section, a generator or compressor that discharges its exhaust directly into intake air that is coursing directly to a return air course, or discharges its exhaust directly into a return air course, is not subject to the applicable requirements of this section.

7.1.3 Requirements for nonpermissible light-duty diesel-powered equipment other than generators and compressors.

Each piece of nonpermissible light-duty diesel-powered equipment other than generators and compressors, introduced into an underground area of an underground coal mine must emit no more than 5.0 grams per hour of diesel particulate matter.