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Artisanal and Small-Scale Miners' Pocket Book

ARTISANAL AND SMALL-SCALE MINING AREA ORGANISATION, OCCUPATIONAL SAFETY AND HEALTH REQUIREMENTS, AND ENVIRONMENTAL RESPONSIBILITY

Sustainable Artisanal Mining Project

Ulaanbaatar 2014

Content

Foreword

More than 20 years have passed since artisanal and small-scale mining (ASM) emerged in Mongolia in the wake of the nation's transition to a market economy. Many people were left unemployed and turned to ASM as a way to sustain their livelihoods, extracting such minerals as gold, coal and fluorspar.

Although it has been four years since the establishment of an ASM legal framework, a number of challenges remain, including mining accidents resulting from insufficient knowledge of, and skills in, occupational safety, conflicts between mining companies and communities, and inadequate market regulations covering ASM-extracted minerals.

To address these challenges, the Mineral Resources Authority of Mongolia (MRAM) has been cooperating with the Swiss Agency for Development and Cooperation's Sustainable Artisanal Mining (SAM) Project and the Ministry of Mining since 2005 in supporting artisanal and small-scale miners' operations within the legal framework and has undertaken a range of related measures. As part of this cooperation, the "Artisanal and Small-Scale Miners' Pocket Book: Artisanal and Small-Scale Mining Area Organisation, Occupational Safety and Health Requirements, and Environmental Responsibility" has been developed with the aim of it becoming an important tool for miners to ensure their safety through environmentally friendly, safe and responsible mining operations.

S. Battulga
Head of the Mining Division
Mineral Resources Authority of Mongolia

Foreword

ASM must attain the highest standards of mining site management and occupational safety and health practices. The "Artisanal and Small-Scale Miners' Pocket Book: Artisanal and Small-Scale Mining Area Organisation, Occupational Safety and Health Requirements, and Environmental Responsibility" is a valuable resource that will help Mongolian miners achieve those standards.

Everyone on a mining site is responsible for ensuring occupational safety and health, including ASM partnership members, leaders, members of site rescue teams, leaders of ASM non-governmental organisations (NGOs) and government officials. The "Artisanal and Small-Scale Miners' Pocket Book: Artisanal and Small-Scale Mining Area Organisation, Occupational Safety and Health Requirements, and Environmental Responsibility" is a vital tool that will enable miners to improve their mining performance within the ASM legal framework and fulfill their responsibilities. The handbook contains information on establishing ASM residential areas, procedures for sinking shafts, support techniques, mining safety, ventilation and improved environmental performance. The information is illustrated in a simple format and is based on the best practices of Mongolian artisanal and small-scale miners.

The SAM Project has supported the development of this handbook in conjunction with the MRAM's ASM Unit with the aim of widely sharing and disseminating best practice standards for ASM operations. We hope readers of this handbook will gain knowledge of safe ASM operations to ensure safe and responsible mining operations that contribute to local economic development.

Patience Singo
SAM Project Manager

Preface

The Swiss Agency for Development and Cooperation (SDC) launched the SAM Project in 2005 with the view that organising and formalising ASM operations through the establishment of a legal framework would mitigate the negative consequences of informal and non-organised mining and support local economic development and poverty reduction in rural areas through ASM job creation and increased incomes in local communities.

The Parliament of Mongolia and the government have taken significant steps towards the regulation of ASM issues and the creation of a favourable legal environment in the past decade. The first step in formalising ASM operations was official Parliamentary recognition of ASM in amendments to the Law on Minerals in 2010 followed by the government's approval of the "Regulation on Extraction of Minerals from Small-Scale Mines".

The SAM Project has also undertaken a range of ASM initiatives, including capacity building and the promotion of attitudinal change among miners aimed at the implementation of the ASM legal framework, helping miners become organised and engage in responsible mining practices, and the promotion of safe, environmentally friendly and economically viable ASM operations. The project also focused on disseminating factual information about ASM to the public and all levels of government.

ASM was integrated into the "State Policy towards the Minerals Sector for 2014-2025", which was approved in early 2014. It states that "the State shall support by policy small-scale miners in cooperating in legitimate structure and improving related legislation". The inclusion of ASM in State policy has generated hope that the challenges facing the sector will in the future be resolved. In this regard, it is important for artisanal small-scale miners to operate within the ASM legal framework and promote organised, safe and environmentally friendly mining operations.

Mongolian artisanal and small-scale miners' operations, best practices and lessons learned demonstrate the importance of properly preparing the mining site before extraction begins, securing mine shafts

with the appropriate supports, using safe mining techniques and tools, and ensuring that operations are environmentally friendly.

ASM accidents are largely the result of inadequate shaft support and shaft collapses, sub-standard lifting equipment that causes people to fall into shafts, an inadequate ventilation system that leads to a lack of air, a lack of complete personal protection equipment and improper use of that equipment, and irresponsible and careless behaviour.

This handbook contains practical instructions and methods that will greatly contribute to miners' compliance with the ASM legal framework, accident prevention, and safe and environmentally responsible ASM operations.

1. Establishing a small-scale mining residential zone

In accordance with the Regulation on Extraction of Minerals from Small-Scale Mines, artisanal and small-scale miners are required to form partnerships, become organised and establish residential zones and household waste-disposal points in areas designated by local authorities. Informal and non-organised mining operations often result in significant environmental damage through a lack of designated residential areas, unregulated waste disposal, and contamination of water and soil, leading authorities to suspend and prohibit mining activities.

Picture 1: An informal and non-organised mining operation

Picture 2: Soum and district governors designate residential zones for miners

ASM residential zones must be established beyond the mining area with guidance from professional organisations appointed by local governments, taking into consideration wind direction.

Picture 3: Miners mark the boundaries of a residential zone

Once a residential zone has been determined, miners must mark its boundaries using material that is available locally, such as wood and rocks, which is then painted white to ensure it is visible.

Picture 4: A household waste-disposal point and toilet in a residential zone

<u>*Requirements for establishing a residential zone*</u>

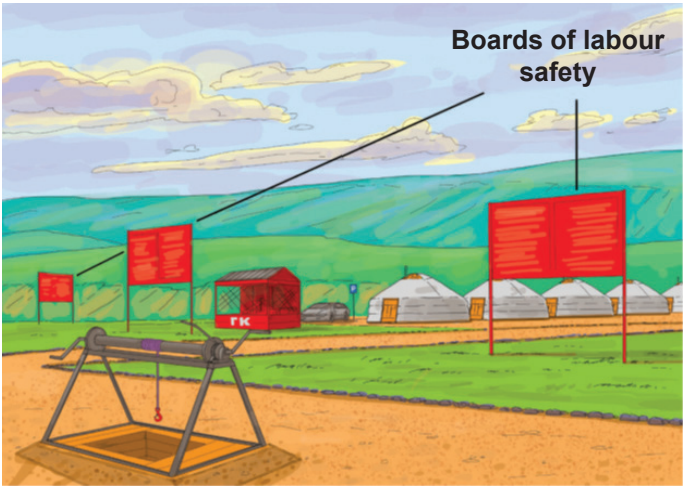
- The distance between gers must be no less than 5m
- Toilets and household waste-disposal points must be established downwind at a distance of no less than 75m from gers

Household waste must be disposed of in three types of containers:

- Green container: Waste that will biodegrade through exposure to rain, sunlight, wind and microorganisms (food scraps and other biodegradable material)
- Blue container: Recyclable waste (bottles, tins, plastic bottles and containers)
- Red container: Other types of waste (such as wood, paper, fabric and ceramics)

Fuel and oil residue must be collected in special containers or barrels and transported to an area in which it can be used or recycled.

A 2-3m deep household used-water disposal pit must be dug alongside the toilet and waste-disposal point, and must have a wooden cover and a ventilation hatch.



Picture 5: A completed residential zone, including a location map and signage

ASM residential zones must also have a parking area and a box containing fire-fighting equipment. A sign bearing the address of the residential zone and a location map should be erected. The location map should be easy to understand. The size of the sign depends on the size of the residential zone. A sign denoting the parking area should measure 45cm x 45cm and feature a white letter "P" on a blue background.

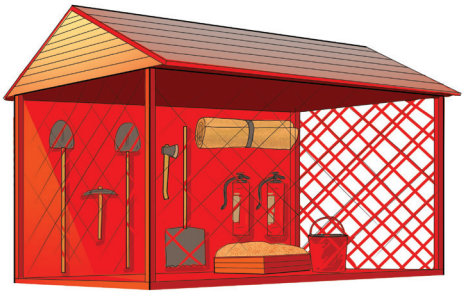
Mining shafts and pits must be separated from residential zones by fences or other protective barriers. Operational safety and health regulations and instructions must also be posted in the area.

Box containing fire-fighting equipment

A box containing fire-fighting equipment must have an iron or wood frame, with metal mesh enclosing the sides. It must be placed in an area that is easily accessible in the event of a fire, notably in the middle of the mining site and residential zone. The box and the equipment it houses must be painted red.

The following equipment must be stored in the box:

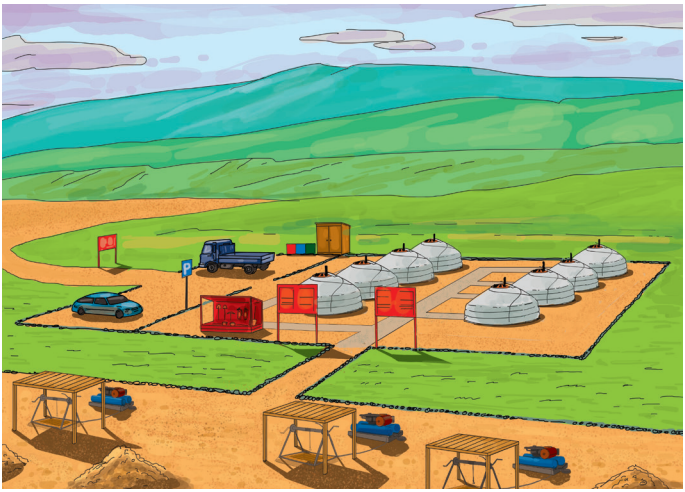
- Bucket
- Sand box
- Shovel
- Fire extinguisher
- Felt
- Crowbar



Picture 6: A box containing fire-fighting equipment

Picture 7: Miners regularly clean the residential zone

Artisanal and small-scale miners' partnerships and NGO members should develop a residential zone cleaning plan and schedule and regularly conduct cleaning activities.



Picture 8: An aerial view of a residential zone

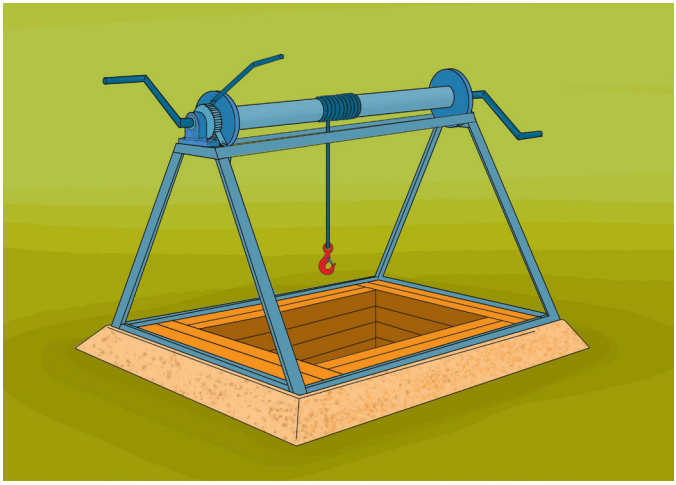
Let's improve our responsibility and wear personal protection clothes.

Let's pay more attention to our lives and ensure our safety.

J.Saruul, Bayanbumbugur NGO,

Bumbugur soum, Bayankhongor aimag

2. Mining shaft organisation and support



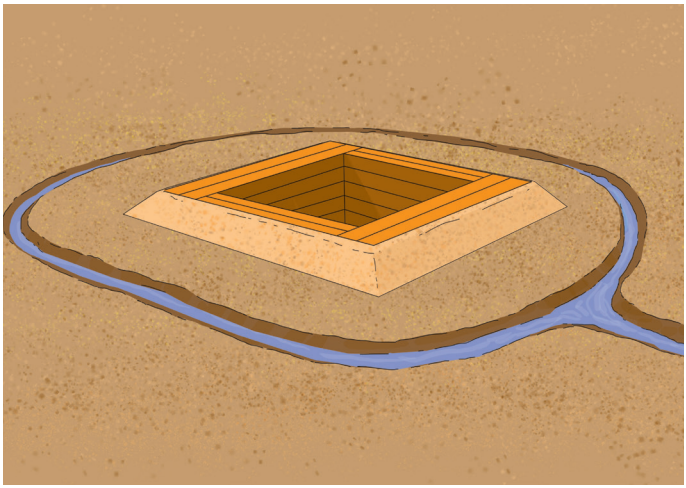
Picture 9: Shaft collar support and lifting equipment

Mining shafts must 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 material such as stones, concrete, wood and sandbags can also be used as shaft supports.

Supporting shaft collar

1. Shaft wall support must continue 20cm above the surface
2. The shaft collar must be framed with thick planks of wood to prevent collapse and the flow of rainwater
3. Trenches must be dug around the entrance to the shaft to channel the flow of rainwater
4. The position of windlass legs should be marked when making the shaft collar support
5. The area around the shaft should be regularly cleaned



Picture 10: Shaft collar support

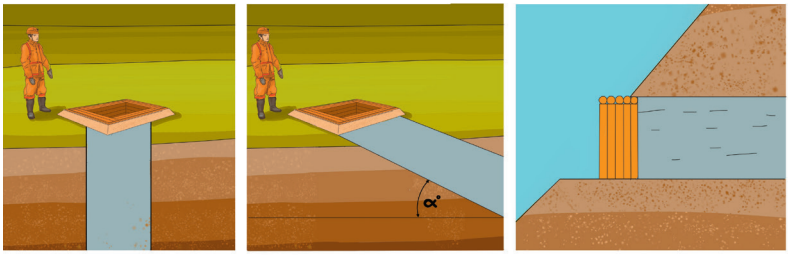
Attention! Please make sure you wear a complete set of personal protection clothes and receive operational safety instructions before starting work.

G. Tsagaan, Kharaa Nutgiin Ajilguichuudiin Kholboo NGO,
Bayangol soum, Selenge aimag

3. Creating a main vertical shaft, supports and OSH requirements

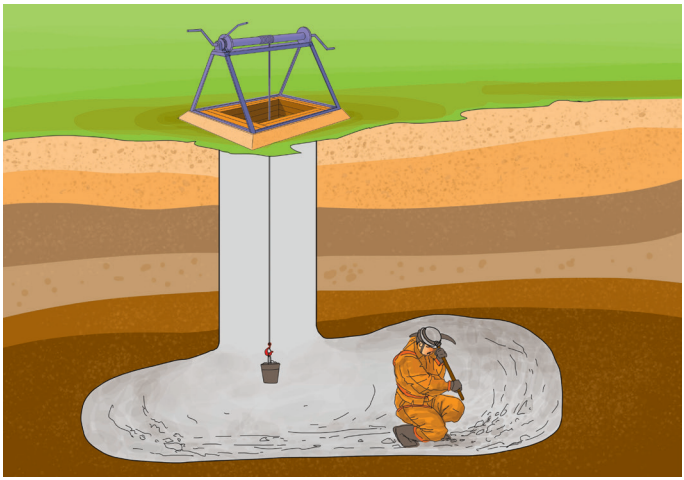
Steps to construct a main vertical shaft

Vertical shafts are dug to allow people to enter and exit mines, to take out ore, and for ventilation. They must be straight on a 90-degree angle and be free from obstacles along the walls that could impede the lowering and lifting of miners and ore. Load must be lifted precisely in the middle of the shaft.



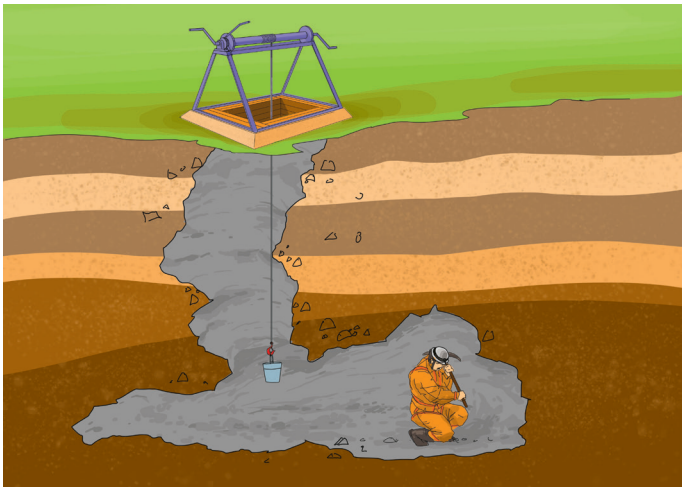
Picture 11: Steps to construct a main vertical shaft

The cross section of the shaft is determined based on overall load volume.



Picture 12: Side view of a vertical shaft

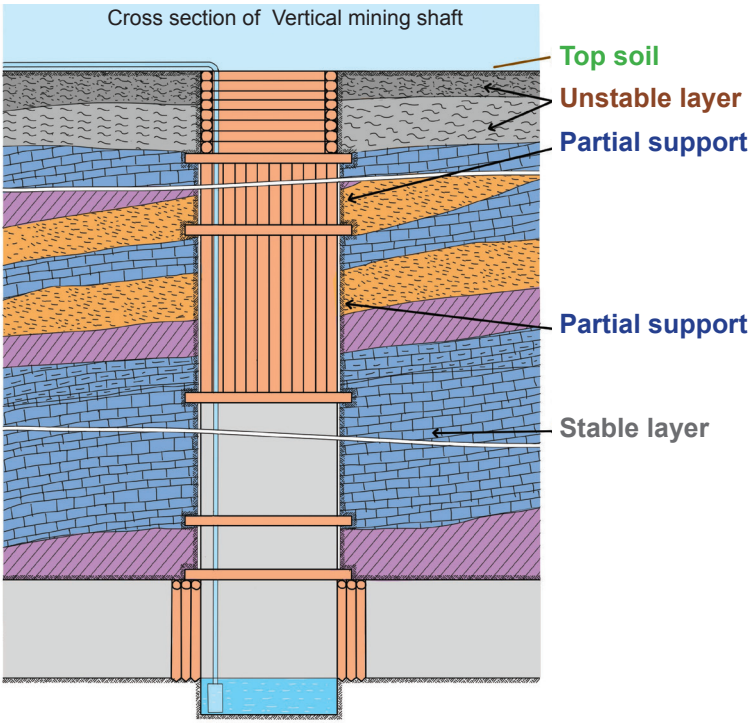
If a vertical shaft is uneven, it poses danger when entering and exiting the mine and there is a risk of collapse and falling stones.



Picture 13: An uneven vertical shaft

Supporting a main vertical shaft

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.

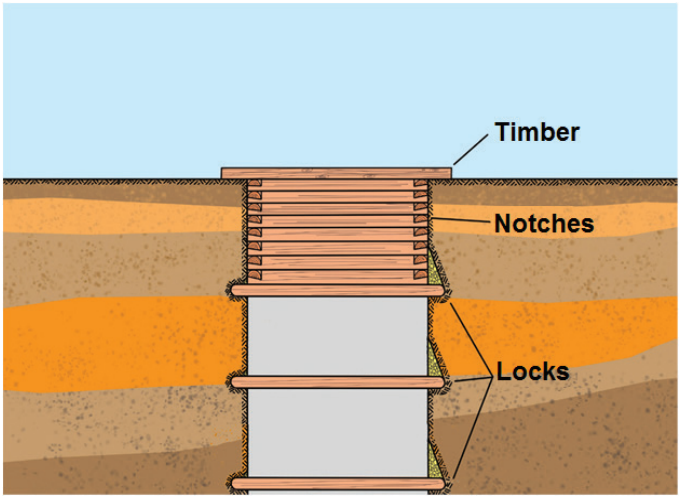


Picture 14: A properly constructed main vertical shaft and supports

Iron, wood, rocks and concrete can be used to support shafts. In ASM, timber is the most suitable material.

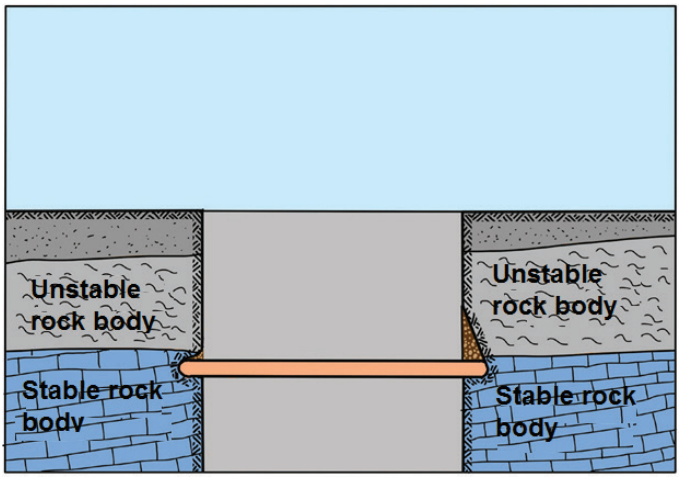
Steps to support a main vertical shaft using timber

The softer, looser rock areas of the shaft must be supported with timber frames with joined notches. This will prevent 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 must be more tightly positioned. When the shaft reaches hard and stable rock, the distance between the support frames can be increased Bark must be removed from the wood as this prevents it from rotting. Timber can be reused in other shafts.



Picture 15: Tightly positioned timber supports in an unstable area of the shaft

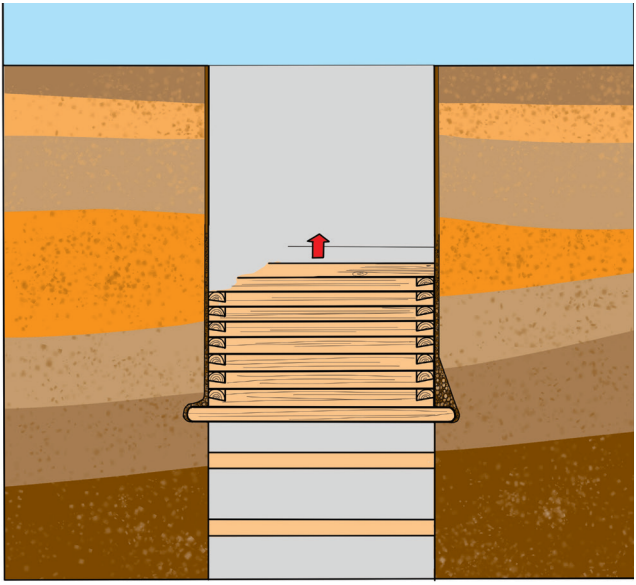
Locks are needed to tighten the timber in unstable rock areas. The timber used for locking must be positioned at the boundary between stable and unstable rock areas.



Picture 16: Locks are positioned at the boundary between stable and unstable rock areas

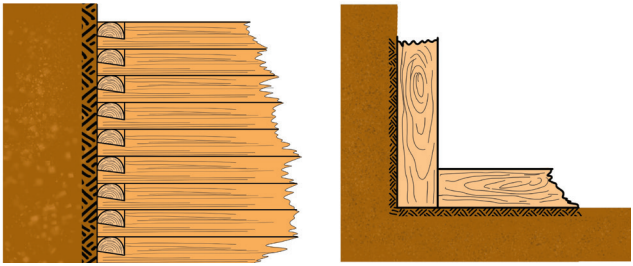
Locking

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.



Picture 17: Timber supports are placed in areas at risk of collapse in a vertical shaft

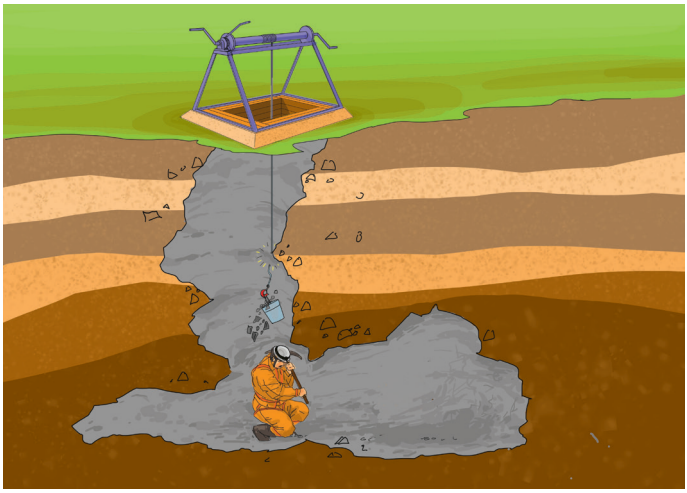
Shaft support frames must be joined with notches.



Picture 18: A wooden support frame connected through notches

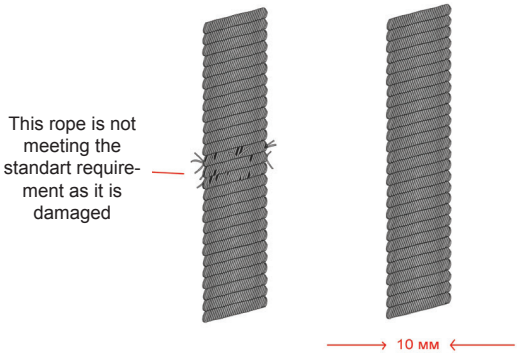
OSH requirements for working in a main vertical shaft

It is prohibited to construct a vertical shaft as illustrated in the picture below. As shown, if the windlass metal cable is constantly in contact with the walls of an uneven shaft, there is a risk that it can fray and break, causing the load to fall on the miners below.

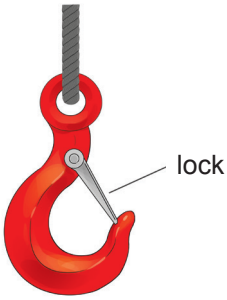


Picture 19: Uneven shafts pose a danger to the miners working below

The windlass metal cable must be undamaged and meet safety standards. Artisanal and small-scale miners must use metal cables that are at least 10mm in diameter and have been inspected and certified.



Picture 20: A metal cable



Picture 21: A hook with a lock

Accidents related to non-compliance with occupational safety and health requirements can occur when people and loads are lifted from and lowered down shafts. To prevent such accidents, it is important to use secure hooks with strong locks that meet safety standards.

Miners must also have a complete set of personal protection clothes and equipment to work in shafts, including a belt and lifting equipment for entering shafts.

Picture 22: Miners are lowered into vertical shafts

4. Shaft ventilation

Air content in the shaft

The air content in shafts must be the same as that on the surface. The air in underground mines is comprised of the following gases:

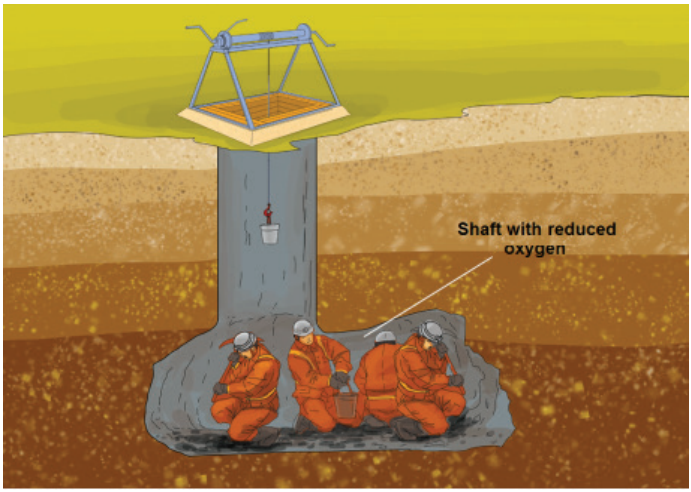
- O2 – Oxygen
- CO2 – Carbon dioxide
- NO2 – Nitrogen dioxide
- SO2 – Sulfur dioxide
- H2S – Hydrogen sulfide
- CH4 – Methane
- C – Carbon

The permissible level of gases in shaft air

Gas	*Permissible level (%)*
Oxygen	**20.95**
Nitrogen	**0-4**
Carbon	**0.03**
Sulfur dioxide	**0.00035**
Hydrogen sulfide	**0.00066**
Argon	**0.93**
Others	**0.01**
Water vapour	**0-4**

If any of these gases exceeds the permissible level, work must immediately stop.

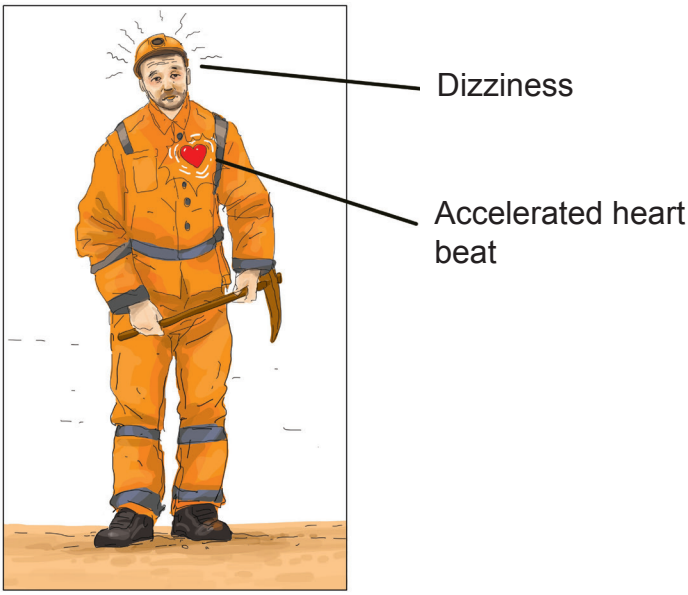
Symptoms of a lack of air



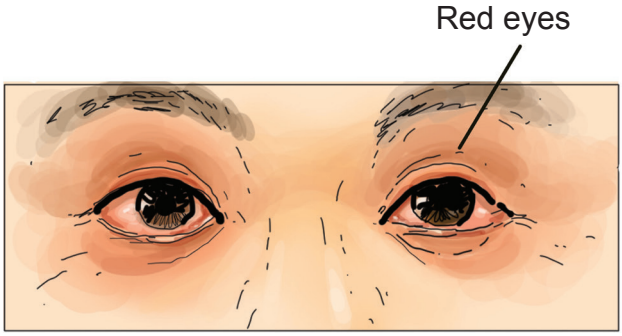
Picture 23: A lack of air in the shaft is dangerous for miners

In Mongolian artisanal and small-scale mines, emissions of carbon dioxide, sulfur dioxide, methane, nitrogen dioxide, and hydrogen sulfide are common. When amounts exceed the permissible levels, miners can experience the following symptoms:

- CO2 – Difficulty breathing, dizziness and blurred vision
- SO2 – A rotten egg smell in the air, nausea and feeling faint. The yellowish colour of sulfur dioxide is visible in the light, generally in the lower part of the shaft as it is denser than air
- CH4 – Odourless and tasteless, methane is highly flammable. It generally concentrates in the upper level of the shaft due to it being less dense than air
- NO2 – A strong-smelling gas that affects skin and respiration and causes eye redness. It is usually emitted after blasting in the shaft and produces nitrogen (N) when it reacts with other gases and water
- H2S – Hydrogen sulfide is emitted from mine walls, and even in small quantities is very hazardous to health



Picture 24: Impure air in mine shafts can cause dizziness and an accelerated heart rate



Picture 25: Red eyes are a symptom of impure air

5. Measuring shaft air content

The air in shafts must be regularly checked. The level of oxygen present is affected by the number of miners working in a shaft and the size of the shaft.

Air content must be assessed before the day's work begins, as stipulated in occupational safety instructions. This can be done using the following methods:

- The use of measuring equipment to determine air content
- The use of such common equipment as candles and oil lamps

Measuring air content using special equipment

Special equipment to measure air content is now widely used in ASM. Individual gases can be measured, with a warning signal given if amounts exceed permissible levels.

Picture 26: Special measuring equipment gauges the level of different gases

Measuring air content using on-hand material

It is common practice for artisanal and small-scale miners to use such equipment as candles and oil lamps to determine air content. Determinations are made based on the following:

- If the flame of a candle or oil lamp burns normally, there is a sufficient level of oxygen
- If the flame is 50 percent less than normal, there is a limited level of oxygen. Miners can work when the level of oxygen is no less than 21 percent of the air content.
- If the flame is more than 50 percent less than normal or the flame dies, the area is potentially fatal

Picture 27: Candles can be used to determine the level of oxygen in the air

6. Shaft ventilation

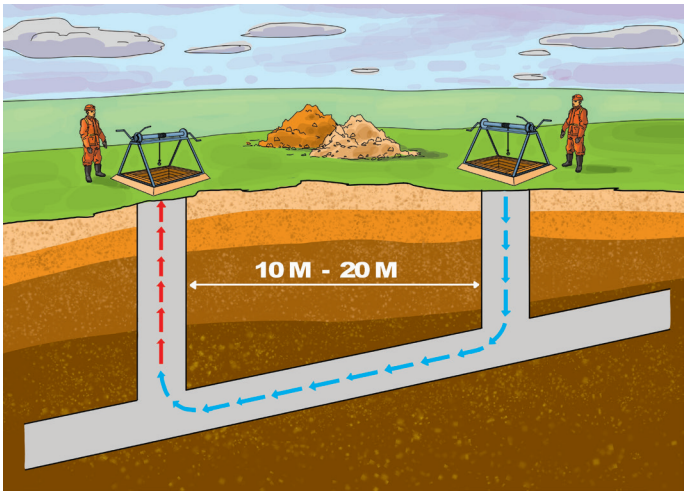
Purpose of ventilation

- To ensure underground miners have a constant supply of air
- To remove toxic gases, dust and smoke
- To ensure comfortable working conditions by adjusting the temperature in mine shafts

Classification of mining ventilation:

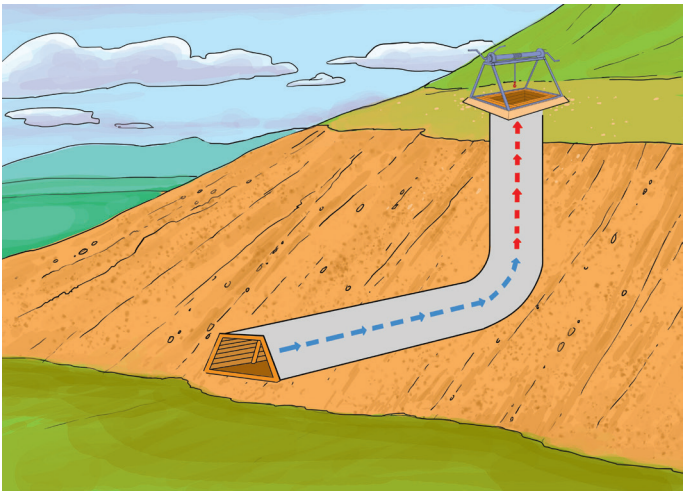
1. Natural ventilation
2. Artificial ventilation

Natural ventilation



Picture 28: Natural ventilation of a mine with two entrances connected by a tunnel

Natural ventilation entails connecting by tunnel two shafts positioned at different heights above the surface. This allows air to circulate freely and also allows for two points of exit in the event of accidents or emergencies.



Picture 29: Air circulation through vertical and horizontal shaft entrances

Artificial ventilation

If a mine shaft is more than 10m in length and the tunnel is more than 20m in length, an artificial ventilation system must be installed. Artificial ventilation pumps clean air into the mine via a fan or pipe.

General method of artificial ventilation

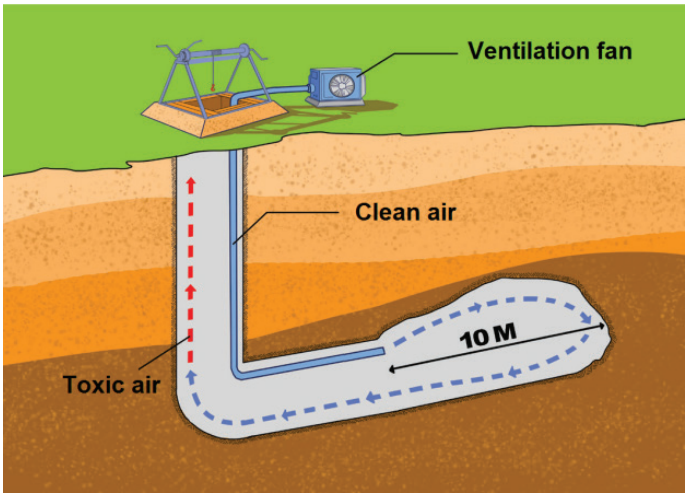
Artificial ventilation takes three forms:

- Sucking
- Pumping
- Combined

The sucking method is employed in mines where toxic gases cannot be removed through natural ventilation. Pumping is used in mines with lower levels of toxic gas emissions. The combined method utilises both sucking and pumping methods and is used in mines where the shaft's resistance is greater than the air flow.

To install a ventilation system, the following steps must be taken:

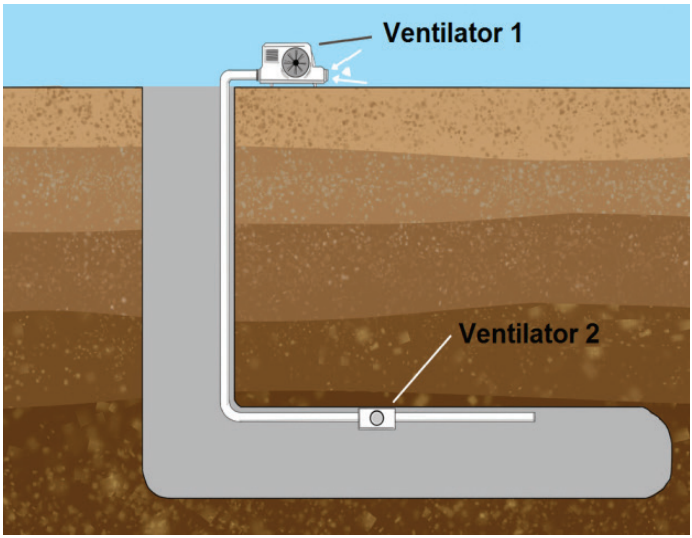
- A metal mesh guard must be placed over the fan
- Pipes used to transfer air must be in good condition, be free from damage and have no breaks
- Pipes must be laid straight
- Pipes must reach close to the bottom of shafts (no more than 10m from the bottom of shafts with a 4m cross-section)



Picture 30: Artificial ventilation system

Pipes must be made from strong and flexible material such as rubber-treated fabric. Pipes must reach the end of tunnels to a distance of no more than 10-15m. In vertical shafts, pipes must go down 5m.

Depending on the length of the mine, either a single fan or double fans should be used.



Picture 31: Artificial ventilation system for an underground mine

The illustration above depicts a double ventilation system for a long mine.

The distance between end of the shaft and the pipe is calculated at 10m for every 4m2 cross-section. For example, if the cross-section of a shaft that is 1.5m high and 1.2m wide is 1.8m2, the pipe must reach 4.5m from the end of the shaft (see the calculation below).

$4м^2$ --- 10м

$1.8м^2$ --- X then X=4.5м

Choosing a proper fan for ventilation

Based on standard ASM practice, it is sufficient to use pipes that are 400mm in diameter and fans that have 1.3-2.5kW capacity and 1000Pa pressure for shafts that are 100m in length and have a 4m2 cross-section. Miners are also widely using industrial ventilation fans with a capacity of 1.8kW and 2700rpm that are available through construction suppliers.

Warning! *Working in mines that are not properly ventilated is dangerous for miners' health and lives. ASM must be conducted with the legal framework.*

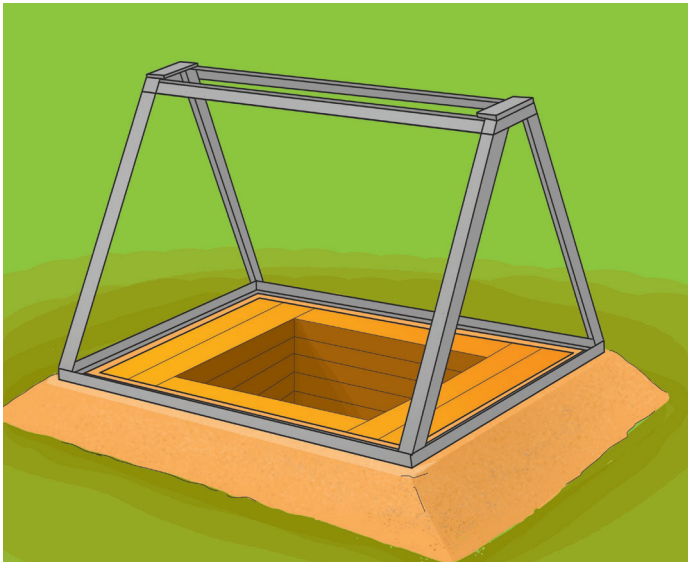
7. Windlasses in artisanal and small-scale mines and OSH requirements

Windlass: A lifting mechanism used in artisanal and small-scale mines

Manual and mechanised windlasses are used in vertical mine shafts to lower and lift miners and ore.

Miners must heed the following when installing windlasses at the entrance to shafts:

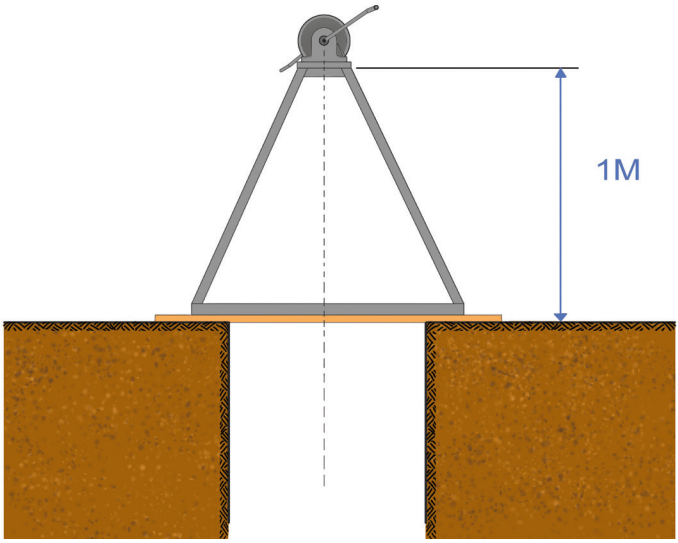
- The four legs of the windlass frame must be securely positioned on solid ground around the shaft collar
- The legs must be connected by a strong metal such as iron to ensure stability



Picture 32: A windlass frame

- The frame should be 1m high on average; however, it is advisable to calculate height based on the height of the miners using the windlass

- If a windlass is not high enough, it can cause miners to suffer back pain
- The windlass must be properly positioned and the horizontal cylinder must be in the centre of the shaft collar

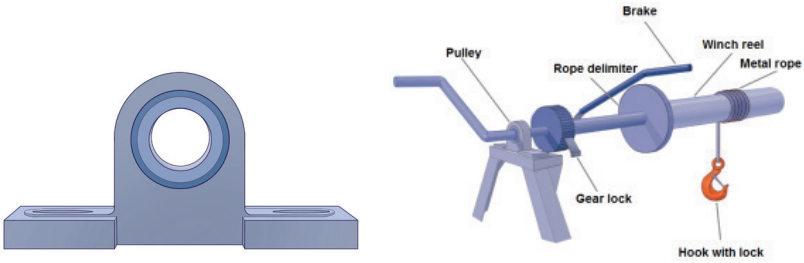


Picture 33: A properly positioned windlass

Parts of a windlass

The lifting mechanism of a windlass is comprised of the following:

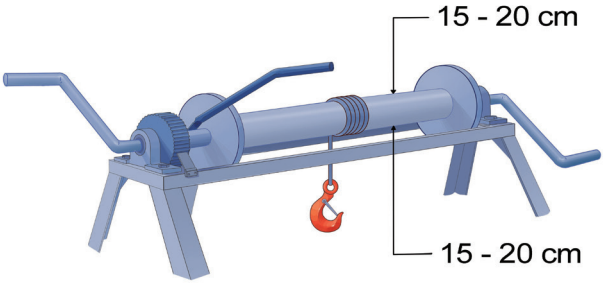
- Gear and lock
- Brake
- Winch reel
- Rope delimiter
- Pulley
- Rope
- Hook with lock



Picture 34: The components of a windlass lifting mechanism

When fabricating a windlass, miners must choose standard parts to ensure safe operations.

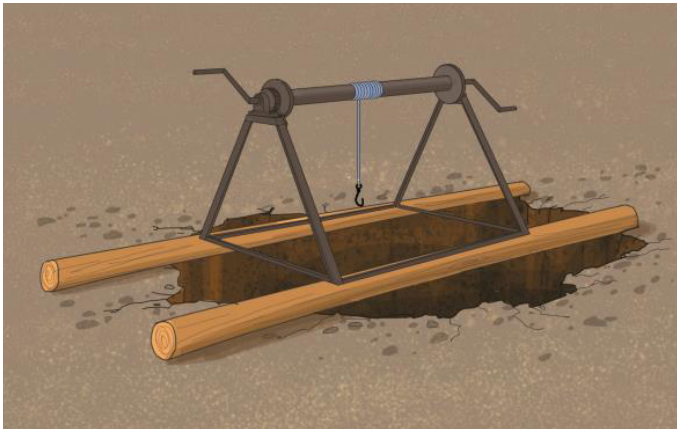
It is important to choose a correctly sized iron pipe for the winch reel as this will contribute to greater productivity and time efficiency. The iron pipe should be 15-20cm in diameter; if it is less than that, more time and energy is required to haul loads as there is less rope coiled around the reel.



Picture 35: The lifting component of a windlass

OSH requirements for ASM equipment

Miners must not work in unsupported mine shafts!



Picture 36: An unsafe shaft that fails to meet minimum mine safety requirements

The illustration above shows non-compliance with mine safety requirements:

- The shaft collar is not secured with supports
- The windlass is incorrectly positioned
- The windlass rests precariously on unstable pieces of wood
- There is no break
- There is no strong hook
- There is no lock on the handle

Miners must be responsible for using safe and complete equipment and for the creation of safe work areas as their lives depend on it.

Danger always follows those who pay no attention!

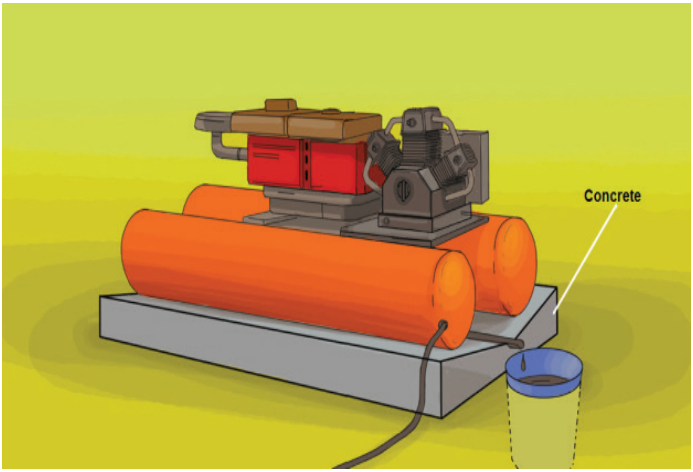
L. Lkhagva, Ekh Oron Khamtiin Khuch NGO
Airag soum, Dornogobi aimag

8. Environmental responsibility

The use of compressors and motors is widespread in the ASM sector in Mongolia. While this increases productivity and cuts down miners' workload, it can lead to environmental damage with soil contaminated by leaking oil. It is therefore vital that miners take steps to prevent environmental harm, including placing either concrete or wooden bases under compressors and motors to collect leaking oil.

Concrete bases

If miners are planning on working in a particular location for an extended period of time, a permanent concrete base for compressors and motors is recommended.



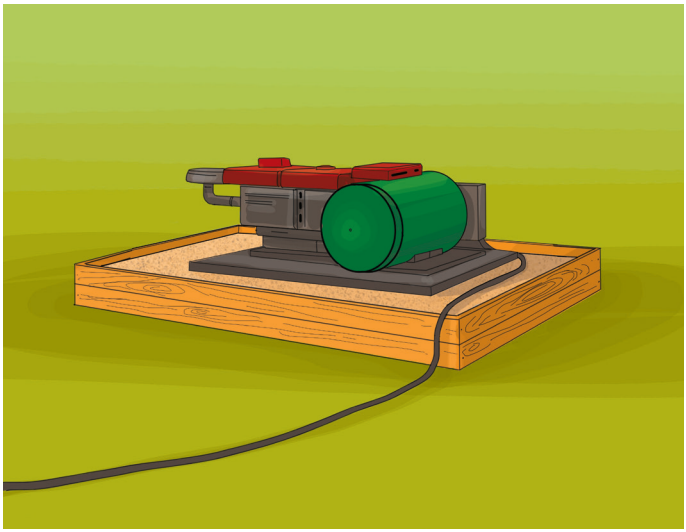
Picture 37: A concrete base prevents soil being contaminated by leaking oil

- Construct a wooden frame and fill it with wet cement
- Before the cement dries, dig a small trench in the middle of the base to channel the oil
- Construct a base on which a small bucket can be placed to collect the oil
- Each side of the base must incline towards the centre

The dimensions of the base are calculated in accordance with the size of the compressors and motors to be used.

Wooden bases

For miners operating at temporary sites, such as placer deposits, it is recommended that they use wooden bases as these can be disassembled and moved to other locations when operations have ceased.



Picture 38: A wooden base for compressors and motors

- Construct a large, flat wooden tray
- Cover the tray with a thick sheet of plastic
- Fill it with sand
- Place the compressor or motor on top of the base to allow leaking oil to seep into the sand

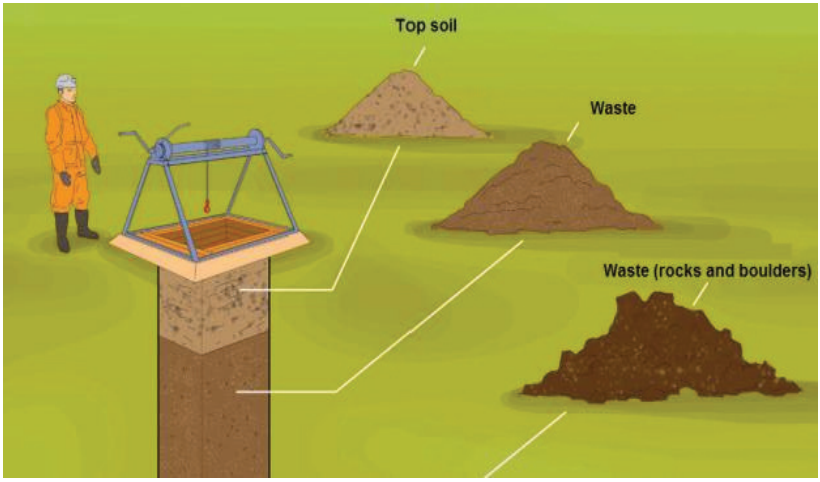
The sand in the tray needs to be regularly replaced and disposed of at the designated waste-disposal point or transported to construction operations for use in such areas as road-building.

9. Technical rehabilitation

Artisanal and small-scale miners must comply with the following requirements for technical land rehabilitation:

1. Fill in shafts with the large rocks and boulders that were initially removed from the shaft
2. Fill shafts with the earth and small stones initially removed from the shaft
3. Replace the topsoil removed during the building of the shaft

Biological rehabilitation must be undertaken after the completion of technical rehabilitation work.

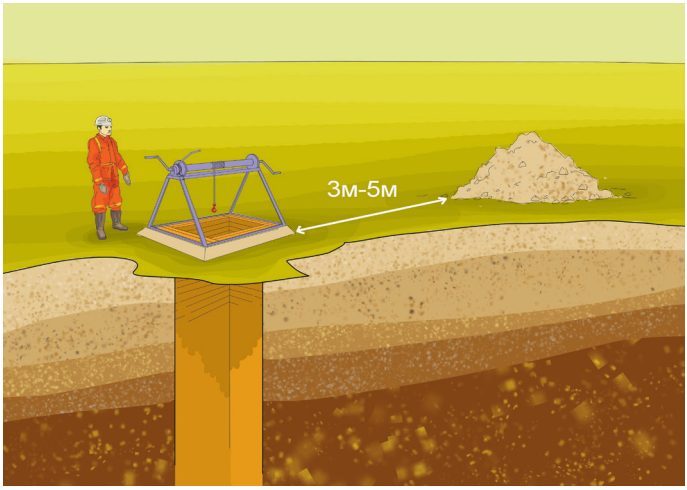


Picture 39: Stockpiling the soil and waste removed from the mine shaft

10. Mining waste management

Mining waste management in a flat area

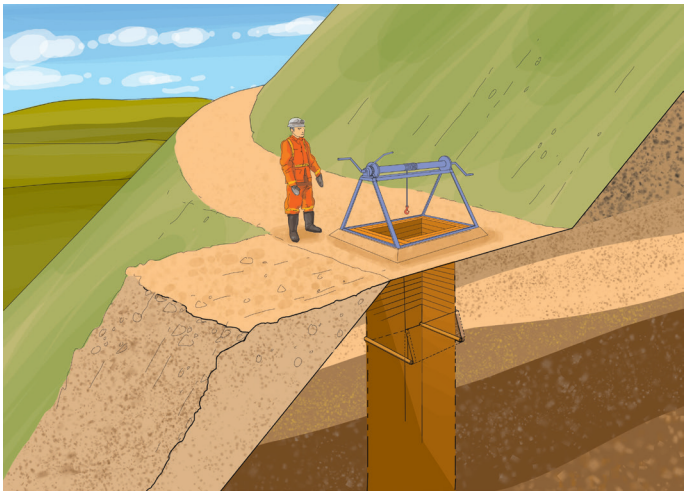
At a flat and even mining site, waste heaps must be placed at least 5m from shafts and care taken to ensure the degree of the heap incline doesn't allow rocks and stones to roll off.



Picture 40: A waste heap in a flat mining area

Mining waste management in an inclined area

In inclined areas, the waste heap must be positioned on the inclining side of a shaft to create a flat area and more work space for miners.



Picture 37: A waste heap in an inclined area

You can protect yourself and others from risks by creating safe working conditions

R. Tumendemberel, XAMO LLC
Bornuur soum, Tuv aimag

11. Common accidents in ASM and their causes

1. Lack of air: Artisanal and small-scale miners burn car tyres to thaw shafts in winter. This produces nitric acid that can result in breathing difficulties, choking, dizziness and blurred vision and can lead to fatal accidents.
2. Collapses: Roof and wall collapses are common at ASM sites as a result of such issues as improper shaft supports, unsafe and unstable mine shafts, and the building of pits with caps in areas where there is loose stone. This can result in injury and loss of life.
3. Insufficient ventilation: A lack of proper ventilation allows for the build-up of toxic gases that can lead to fatal accidents.
4. Lack of individual responsibility: The main cause of ASM accidents is miners' carelessness and ignorance of safety instructions and requirements. It is therefore vital that miners take responsibility for their lives and their health.
5. The main priority for miners is to ensure they are fully equipped with personal protection clothes and gear and that they are creating safe working conditions.