



INTERNATIONAL MINES RESCUE BODY
conference
colombo
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CLOMA



Technology in Portable or Fixed Shelters for Underground Mining

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- Introduction
- International regulations and standards
- Underground portable and fixed mining shelters
- Recommendations for the implementation of a portable or fixed mining shelter
- Design and installation of a fixed mining shelter for 260 people
- Questions

Introduction

Emergency plans

In an underground work environment, miners are exposed to many potential toxic gas hazards. Therefore, every underground mine must have an emergency plan that should include proper hazard identification and risk analysis in case of fire and/or toxic gases.



Introduction

Emergency plans



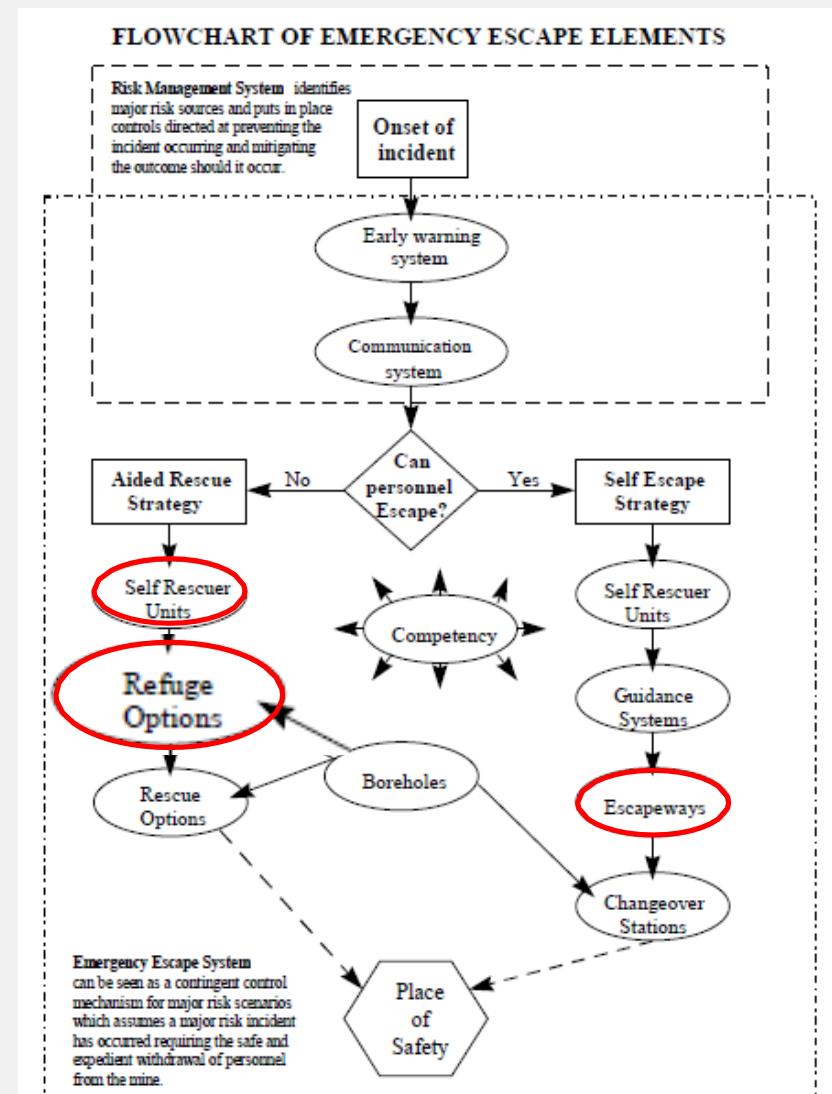
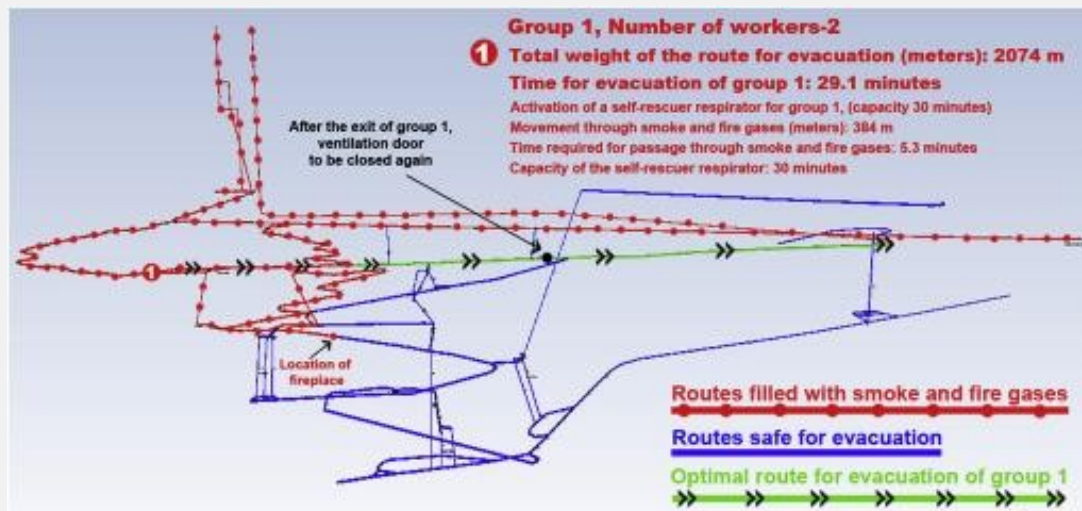
Year	Place	Number of casualties and injured people	Kind of accident
1928	Hollinger Consolidadtd Mine, Canada	39 dead	Fire inside the mine Death due to CO inhalation
1945	Codelco El Teniente, Chile	355 dead 747 injured	Fire inside the mine Death due to CO inhalation
1958	Codelco El Teniente, Chile	103 injured	Intoxication due to fougasse gases “polverazo”
1972	Sunshine Mine en Idaho, EE.UU.	92 dead	Fire inside the mine Death due to CO inhalation
1973	Minera Los Bronces, Chile	3 dead	Fire inside the mine
1977	Minera Los Bronces, Chile	2 injured	Fire inside the mine
1990	Ruttan Mine Northern Manitoba, Canada	38 rescued	Fire inside the mine
1990	Ontario, Canada	27 rescued	Fire inside the mine

Introduction

Emergency plans

An emergency plan work flow should incorporate:

- Implementation of quick, safe and properly signaled escapeways
- Self-rescue systems to leave the mine or the shelter
- Portable or fixed refuges



Introduction

Emergency plans



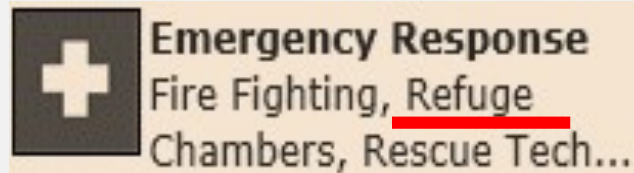
Because the installation of underground portable or fixed shelters is a basic security issue intended to provide a place where people can be safe from intoxication, some criteria will be followed from a worst-case scenario perspective.





30 CFR § 57.11050

«Every mine shall have two or more separate, properly maintained escapeways to the surface from the lowest levels», «refuges must be positioned so that the employee can reach one of them within 30 minutes from the time he leaves his workplace»



Center for Disease Control and Prevention - USA



International regulations and standards



Occupational Health and Safety in Mining, Decree 055- 2010-EM and Decree N° 024-2016-EM, Annex 19

“Every underground mine shall have shelter stations so that in case of an emergency the staff has a place to isolate themselves. It must be able to supply enough air and drinking water for at least **72 hours”.**



Official Mexican Law NOM-023-STPS-2012, Occupational Health and Safety Conditions – Underground and Open Pit Mining

“The size, number and location of shelters inside underground mines must be determined by:
a) **The annual analysis made to identify the hazards and control the risks;**
b) **The likelihood of fire or landslide, and**
c) **The progress of work fronts”**



Mining Safety Regulations - Decree 132, Article 100

“Every mine shall have internal refuges, which must provide enough life-sustaining supplies for at least 48 hours to guarantee the survival of trapped people in case of an emergency”.



Underground Mining Safety Regulations
Mining Decree 1886

“Article 29. Emergency plan. Every underground mining Company must create an emergency plan according to Numeral 18, Article 11, Resolution 1016 of 1989 issued by the Ministries of Labor and Social Security and Health, or any other provisions that modify, add to or substitute it”

International regulations and standards



Occupational Health and Safety in Mining, Decree 055- 2010-EM and Decree N° 024-2016-EM, Annex 19

“Shelter location must guarantee that workers are able to reach them within 30 minutes after leaving their workplace”

“The number and location of refuge shelters will be determined **by a risk study** of the mining unit”

“Their location will depend on the progress of work fronts within **500 meters of the fronts**”



Official Mexican Law NOM-023-STPS-2012, Occupational Health and Safety Conditions – Underground and Open Pit Mining

“Shelters must be stocked with life-sustaining supplies to guarantee survival of workers inside the shelters for at least **96 hours**”.



Mining Safety Regulations - Decree 132, Article 100

The location of shelters will depend on the progress made **by work fronts**. If possible, they should be movable”.



Underground Mining Safety Regulations
Mining Decree 1886

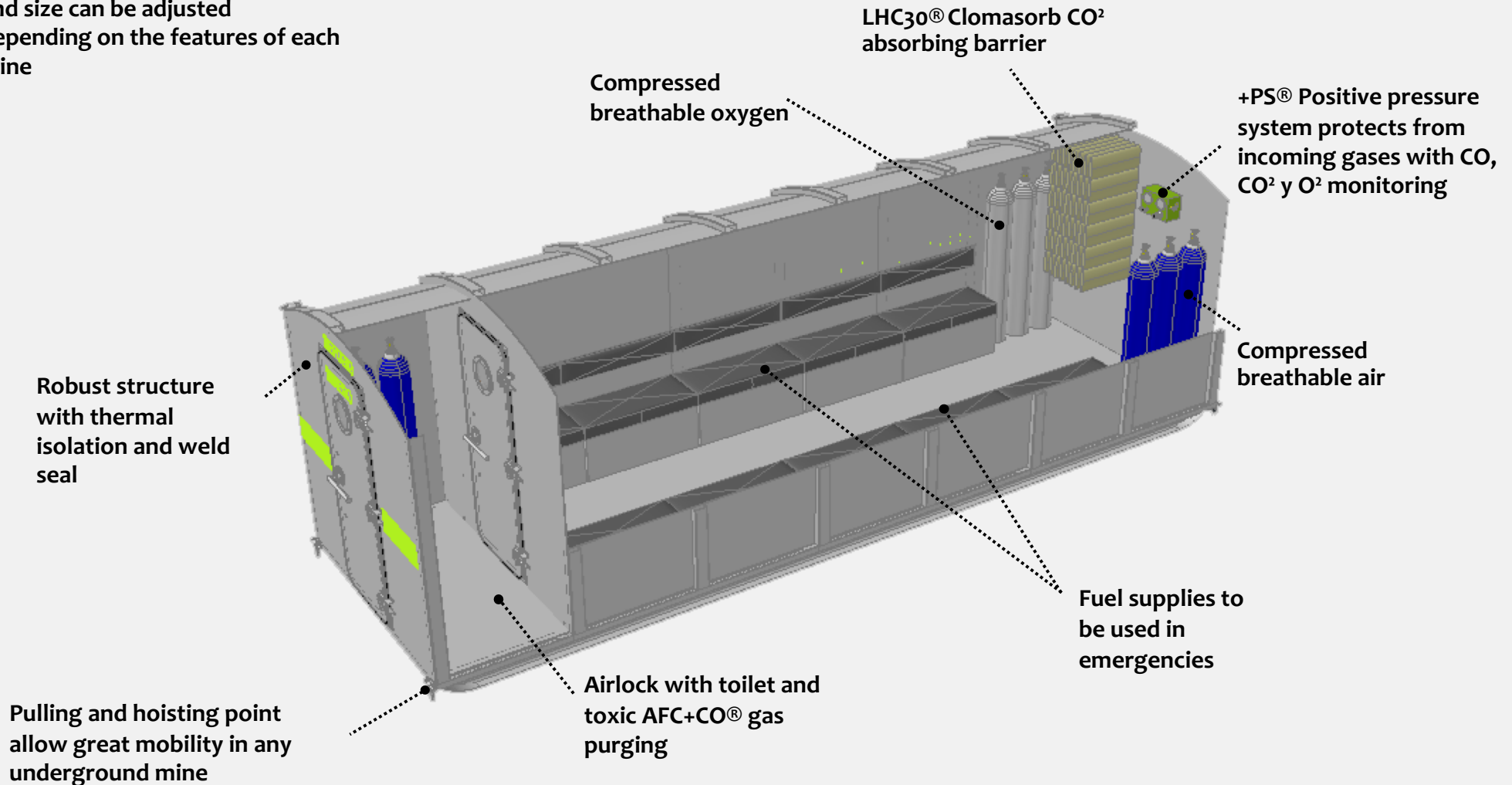
“Paragraph. **Every mine must have internal safe havens**, which must be stocked with life-sustaining supplies to guarantee the survival of people after an emergency event. Mines will have one year after this regulation is issued to implement such refuges”.

Portable Underground Mining Shelters

A solution for the coal mining industry



Referential image. Actual design and size can be adjusted depending on the features of each mine

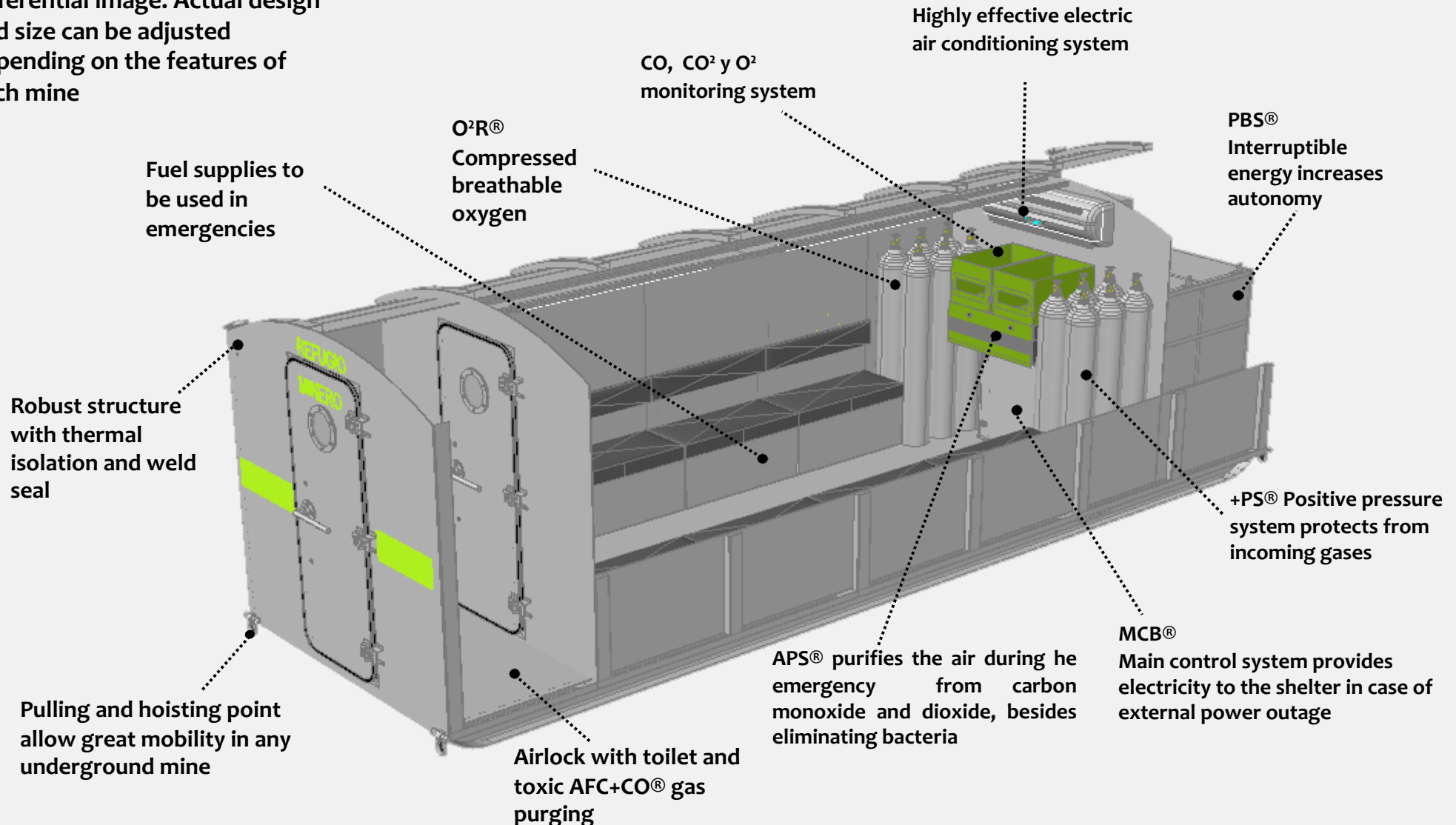


Portable Underground Mining Shelters

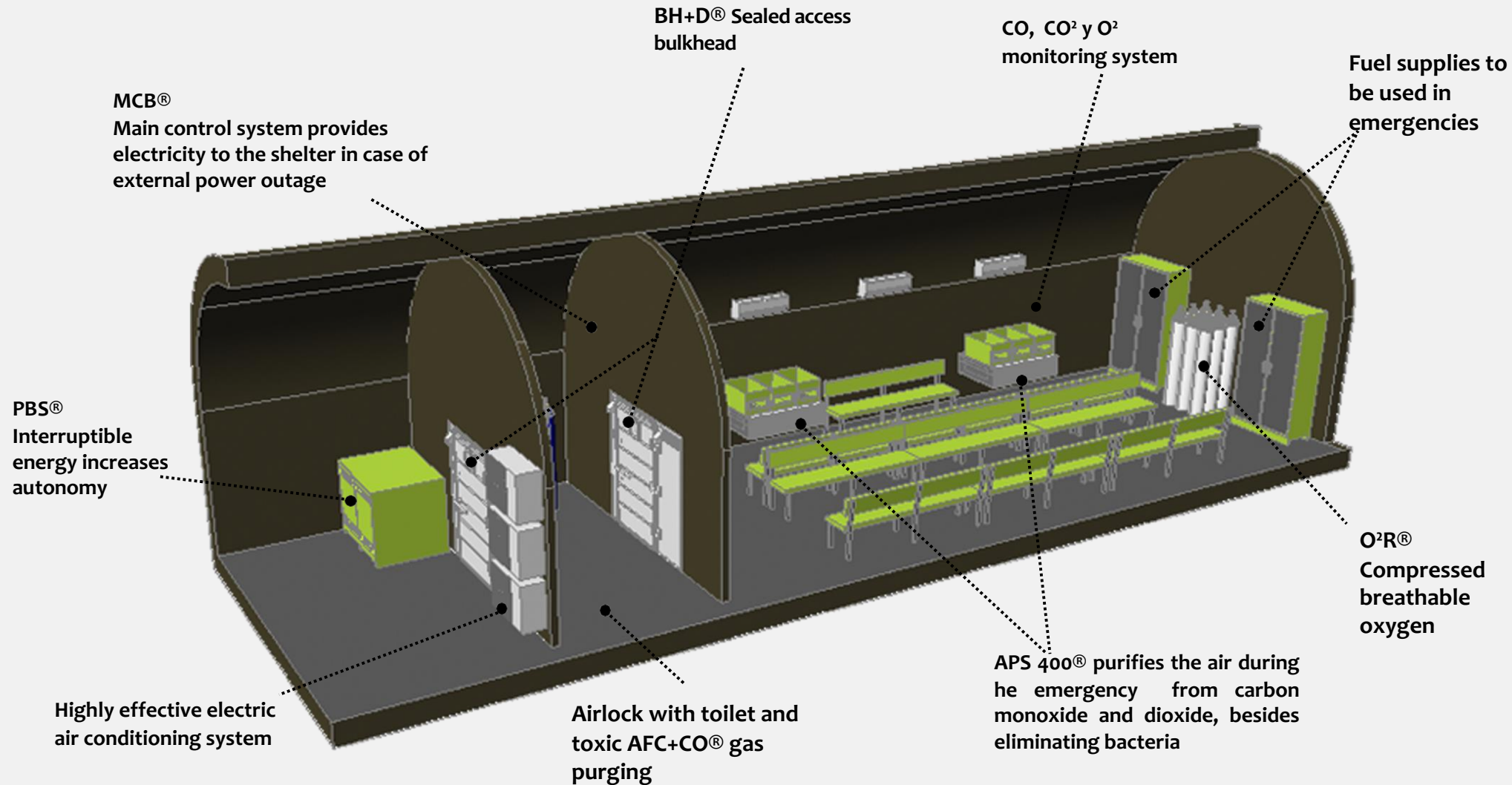
Solutions for the Metal and Nonmetal Mining Industry



Referential image. Actual design and size can be adjusted depending on the features of each mine



Portable Underground Mining Shelters Solutions for the Coal, Metal and Nonmetal Mining I



Recommendations for Implementing a Portable or Fixed Mining Shelter

CRITERIA TO DETERMINE SELF-RESCUE SYSTEM “EVACUATION SPEED”



Average evacuation speed at any level is 75 [m/min] in normal conditions (considering that a person walks at 4,5 km/h).

Recommendations for Implementing a Portable or Fixed Mining Shelter



CRITERIA TO DETERMINE SELF-RESCUE SYSTEM “EVACUATION SPEED”



In case of fire, due to reduced visibility caused by smoke, toxic gases, temperature, lack of coordination, steep roads or stress, among others, evacuation speed decreases to an average speed of 25 [m/min]. (66% less speed)

Recommendations for Implementing a Portable or Fixed Mining Shelter



CRITERIA TO DETERMINE SELF-RESCUE SYSTEM “EVACUATION SPEED”



People walk more slowly due to changes in elevation and the negative factors generated by fire. Because of these factors, average evacuation speed for people using chimneys with ladders in an emergency has been estimated at 3 [m/min.] (including breaks), depending on chimney length.

Recommendations for Implementing a Portable or Fixed Mining Shelter



CRITERIA TO DETERMINE SELF-RESCUE SYSTEM “CRITICAL DISTANCE”



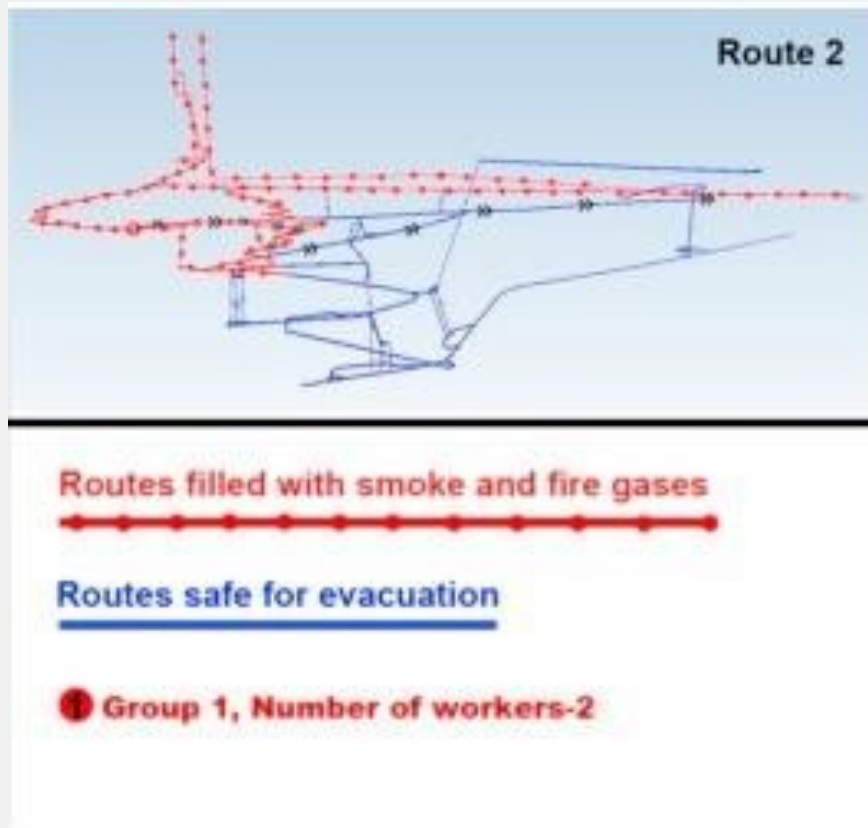
Critical distance is the longest tranche someone can walk while using the self-rescuer from the moment the fire signal is received.

The most commonly used self-rescuers are the “open circuit” type and last 60 [minutes]. However, they only provide protection from carbon monoxide and should not be used in atmospheres containing less than 19,5% oxygen or other toxic gases. As a general criteria, a 50% safety is considered for estimating a maximum duration of 30 minutes.

If we estimate the critical speed, the duration of the self-rescuer and the safety factor, the critical distance is 750 [m] and 90 [m] through chimneys.

Recommendations for Implementing a Portable or Fixed Mining Shelter

DISTRIBUTION OF MINING SHELTERS “SAFE ZONE / CRITICAL ZONE”



Safe zone: Area where, in case of fire, there is enough fresh air and personnel are safe from toxic fumes and gases that could potentially cause poisoning, such as fresh air injection galleries when walking towards the surface.

Critical zone: An area far from the safe zone whose evacuation distance exceeds the specified critical distances (750 and 90 [m]). Also, an area that only has one access and that could be obstructed in case of an accident.

Recommendations for Implementing a Portable or Fixed Mining Shelter



DISTRIBUTION OF MINING SHELTERS “SAFE ZONE / CRITICAL ZONE”



Another factor when considering a critical area is the number of people working in the affected area or close to it. As a result of fire, emergency exits in the area could be insufficient, for example auxiliary chimneys.

These criteria will determine the need to install mining shelters in all those critical areas where staff is working or passing by.

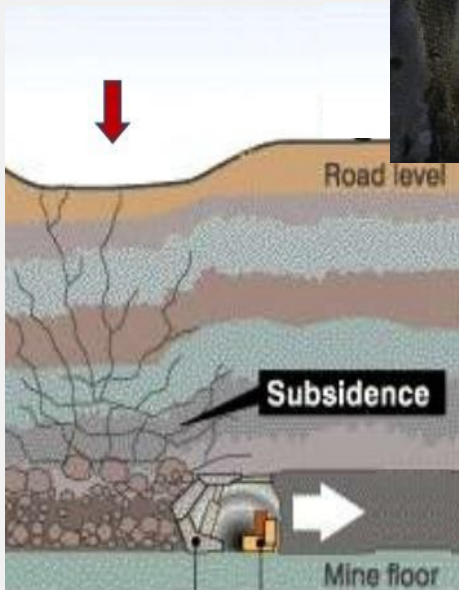
Recommendations for Implementing a Portable or Fixed Mining Shelter



DISTRIBUTION OF MINING SHELTERS “LOCATION OF MINING SHELTERS”

The main criteria to locate mining shelters is they should be easily accessible, preferably in main access or transit areas. Visibility of these shelters is vital.

In order to maximize useful life of the mining refuges, their location must guarantee that they won't suffer due to blasting, abutment stress, team traffic or flooding. Ideally, they should be located in areas with strengthened rock, both in terms of location and access.



Recommendations for Implementing a Portable or Fixed Mining Shelter

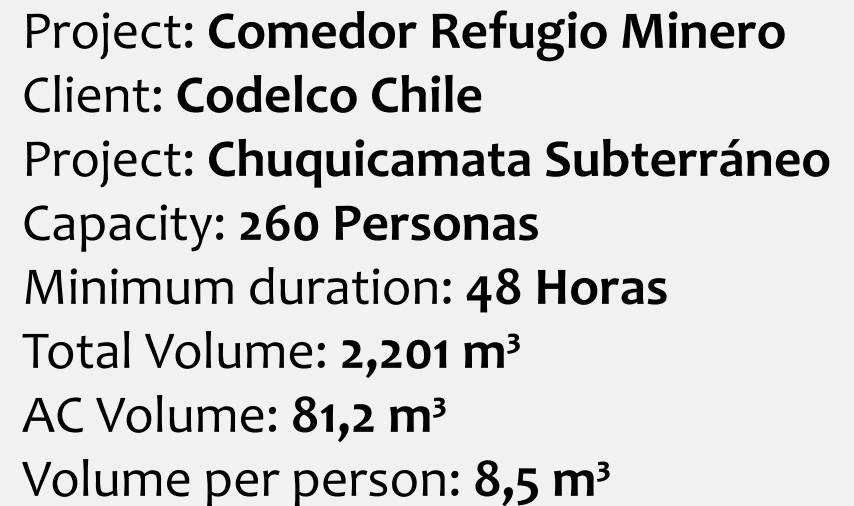
DISTRIBUTION OF MINING SHELTERS “RESTRICTIONS”



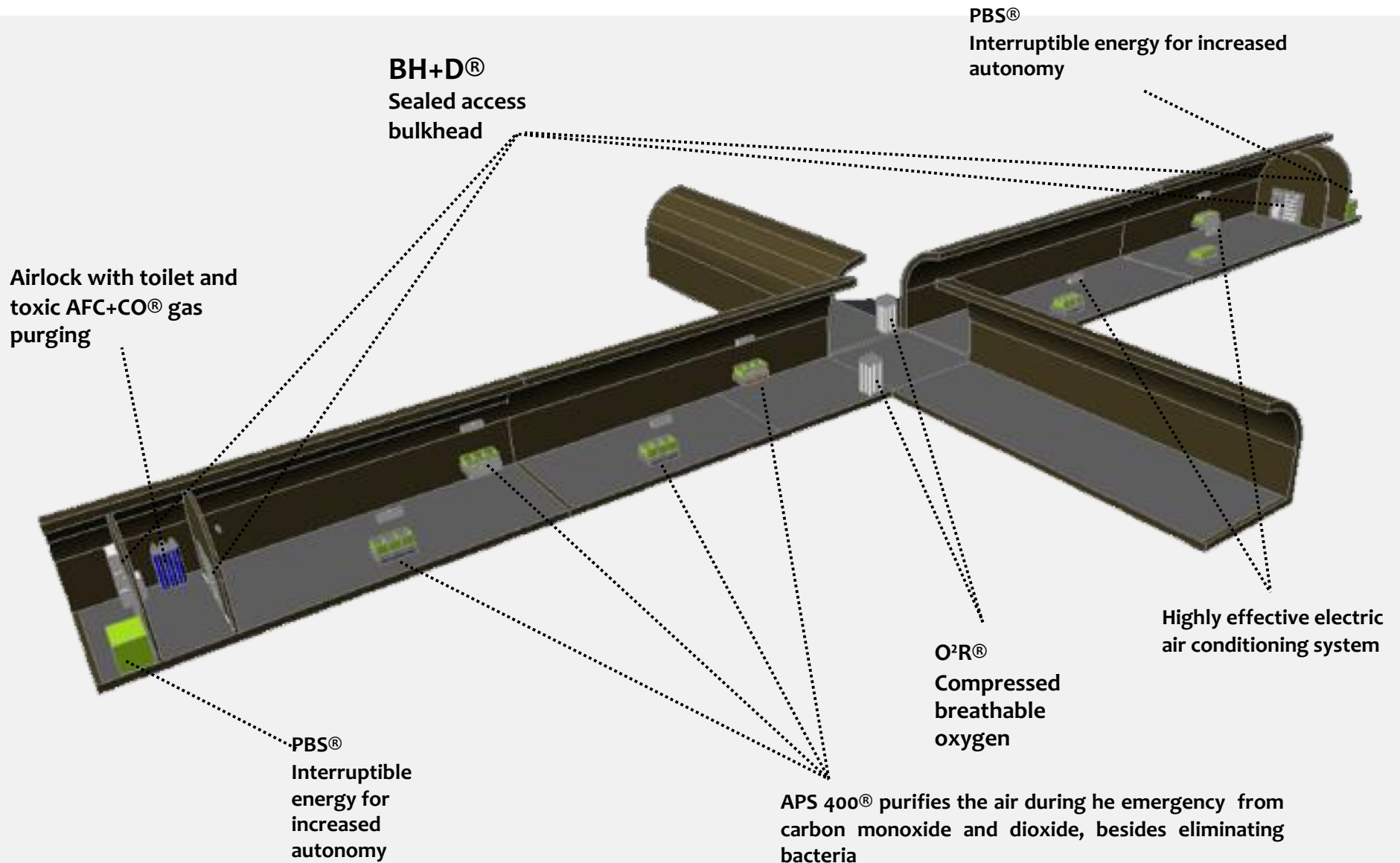
As far as possible, shelters should not be located in residential neighborhoods, unless they are critical zones. They should be located further away from the minimal distance for shelter location in potential fire areas. The safe distances for risk areas are:

- At least 60 meters away from munition dumps or explosive storage rooms.
- At least 15 meters away from electrical transformers over 5kVA.
- At least 20 meters away from conveyor belts.
- At least 60 meters away from repair areas.
- At least 60 meters away from fuel storage areas.

Mining shelters be located between 350 – 600 m away from work fronts, avoiding linear locations because of the risk of being hit by shocking waves.



Design and installation of a fixed shelter for 260 people - PERSPECTIVE



Design and installation of a fixed shelter for 260 people



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Design and installation of a fixed shelter for 260 people



Thank you for your attention!



Questions?

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