From: Hart, Marley@DIR
To: Quinonez, Michele@DIR
Subject: FW: MineARC Systems - petition to modify Cal/OSHA tunneling regulations
Date: Tuesday, March 19, 2013 4:10:47 PM
Attachments: image001.png
MineARC Systems petition of Cal OSHA Article 8.pdf
TBM Refuge Brochure.pdf

Michele,

This is a new Petition. It will be assigned to Conrad.

Marley

From: Rob Frashefski [mailto:Rob.Frashefski@minearc.com]
Sent: Tuesday, March 19, 2013 10:30 AM
To: Hart, Marley@DIR
Subject: MineARC Systems - petition to modify Cal/OSHA tunneling regulations

Dear Ms. Hart,

Thank you for taking the time recently to point me in the right direction on how best to present our petition to Cal/OSHSB, as it pertains to Article 8, underground refuge chambers. Our intention is to shed light on the life-threatening risks associated with underground entrapment, the technologies available to mitigate these risks, and what Cal/OSHA can do to dramatically increase the level of safety of underground workers in this particular industry through simple, yet straight forward standards regulation.

Attached for your review is a detailed recommendation to the board, and also a product brochure – although this is not a sales call, I thought it would help give some insight to our company, relevance to this petition and provide a visual example of the type of technologies we are recommending to the board.

I look forward to presenting at one of the upcoming public meetings if and when the opportunity presents itself – and am here to answer any questions you may have.

Regards,

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March 19, 2013

Marley Hart
State of California / Department of Industrial Relations
2520 Venture Oaks Way, Suite 350
Sacramento, CA 95833

Re: Petition to Amend Cal/OSHA Div. 1, Ch. 4, Sub Ch. 20 (Article 8 – Refuge Chambers)

Dear Ms. Hart,

Thank you for taking the time recently to discuss petitioning procedures for the California Occupational Safety and Health Standards Board. MineARC Systems would like to recommend amendments to Sub Chapter 20, Tunnel Safety Orders, to dramatically improve the level of safety provided to workers in underground tunneling operations. Following is an outline of what we encourage the board to consider:

Existing Regulation:

*(j) A **refuge chamber** or alternate escape route shall be maintained within 5,000 feet of the face of a tunnel classified as gassy or extra-hazardous. Workers shall be provided with emergency rescue equipment and trained in its use. Refuge chambers shall be equipped with a compressed air supply, a telephone, and means of isolating the chamber from the tunnel atmosphere. The emergency equipment, air supply, and rescue chamber installation shall be acceptable to the Division.*

Deadly Hazards Associated with Entrapment:

It is encouraging to see that Cal/OSHA specifies the use of refuge chambers in lieu of alternate escape routes in tunneling operations; however Subchapter 20 is unclear as to what a refuge chamber actually needs to include, to provide life support once occupied. Best practices for refuge chamber design incorporate a great deal of technical advancement and functionality to support life during a wide range of emergencies including fires, smoke, rock fall and inundation (flooding). During these types of events, workers seeking safety in a refuge chamber will likely encounter one or more (or very possibly all) of following life threatening scenarios, if best practices are chosen to be ignored:

- **Failure of Compressed Air Supply** (as is required in Article 8) – compressed air lines are likely to fail during fire, due to burning of rubber air lines and Victaulic couplings on hard-piped systems.
- **Oxygen Supply** – When compressed air fails, refuge occupants no longer have a source of fresh breathing air. Oxygen will quickly be depleted through normal breathing in the now completely-sealed refuge chamber.
- **Carbon Dioxide** – When compressed air fails, occupants no longer have the ability to flush carbon dioxide (CO_2) from within the now-sealed chamber. CO_2 is exhaled by occupants during normal respiratory activity at rates varying from 1-1.7 cubic feet per hour. CO_2 concentrations

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will rise to toxic levels rapidly, if it is not flushed or otherwise mitigated within the chamber. CO_2 asphyxiation is then very likely.

- **Carbon Monoxide (CO)** - in a fire, carbon monoxide is always present and very likely to be introduced into the chamber upon entry by occupants. It can also be siphoned into the chamber through a failed compressed air line (as in item 1 above) before the supply is isolated by the occupants. CO is also endogenously produced by smokers and added to the sealed refuge interior.
- **Heat & Humidity** - Apparent temperature (combination of dry bulb temperature and humidity) inside the sealed refuge chamber is very likely to rise to deadly levels due to ambient temperatures, metabolic heat from occupants and other sources such as electrical equipment. *MSHA CFR 30 Part 7 Refuge Alternatives for Underground Coal Mines specifies the maximum apparent temperature for long term exposure of no greater than 95 degrees Fahrenheit* – which is likely to be exceeded inside the refuge chamber very quickly without the use of a properly sized cooling/dehumidifying system.

International Standards:

Since 2011, MineARC Systems has been a contributing member of the International Tunneling and Underground Space Association (ITA), Work Group 5; an international consortium of tunneling engineers, manufacturers and contractors tasked with improving tunneling safety guidelines worldwide. Refuge chambers are one aspect of the ITA guideline that MineARC has been particularly involved in, and we would like to share our recommendations with you with the goal of improving safety for underground workers in the State of California.

Additionally, progressive international standards currently exist that take into account the advances in technology and equipment available to the tunneling industry. Notably, *British Standard BS 6164:2011 Code of Practice for Health and Safety in Tunneling in the Construction Industry*, is one example that focuses specifically on the aforementioned risks of entrapment; including structural integrity, stand-alone duration, occupancy, breathing air supply (both before and after compressed air failure), mitigation of CO_2 and CO buildup and control of heat within the chamber. Likewise, MineARC Systems would like to make Cal/OSHA aware of the technologies currently available to the tunneling industry, and make specific recommendations for protection of workers and visitors in underground tunneling operations throughout the state.

Recommended Amendments of Subchapter 20:

MineARC Systems recommends that Cal/OSHSB consider the addition of refuge chambers as a requirement in ALL underground tunneling operations, where secondary escape is not available, or where other concerns may exist. This should include extra-hazardous (gassy) tunnels as well as standard (non-gassy) facilities. *Reason: Entrapment due to fire is very likely in any single-entry underground operation, regardless of whether it is gassy or non-gassy.*

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To mirror our on-going efforts with the ITA, and additional international tunneling regulations, MineARC Systems recommends the following minimum amendments (requirements) to Cal/OSHA Subchapter 20, for ALL tunnel types:

1. **Refuge Chambers** - In lieu of a person's inability to exit a tunnel within 50% of the designed operational duration (working time) of their self-rescuer, a refuge chamber is to be provided capable of ensuring safe respirable atmosphere independent of tunnel conditions (i.e.: in the event of failure of compressed air feed or loss of main electrical power supply). Refuge to be constructed of fire resistant material, able to maintain a positively pressurized and sealed internal atmosphere.
2. **Occupancy** – Refuge chambers should be sized accordingly to provide a safe go-to area for maximum number of crews and visitors in underground workings, at any given time.
3. **Entrapment Duration** – Refuge chamber entrapment duration is the chambers ability to provide maximum number of occupants with breathable air, cooling and potable water for a specified length of time, with no assistance from external compressed air supply or main power supply. Refuge duration should be considered very carefully, taking into account time needed to extinguish a fire, time needed to safely re-approach a vehicle fire (i.e.: fuel or tire explosions), as well as time needed to re-establish ventilation within a tunnel and mobilize rescue crews. *MineARC Systems recommends 36 hours minimum stand-alone refuge duration for most applications.*
4. **Primary Life Support (External Compressed Air)** – Refuge to include compressed air system capable of providing minimum 3 cubic feet per minute (CFM) per occupant, with means of regulating flow and isolating system during emergencies. System should include filtering or other means of ensuring breathing air quality, with ability to remove moisture (condensation) accumulation prior to introduction into the refuge.
5. **Positive Pressure** – Refuge system should include automatic means to ensure that internal pressure (i.e.: from compressed air system) is relieved at maximum 0.18 psi. *Note: Equivalent to MSHA 30 CFR.*
6. **Secondary Life Support (Oxygen Supply) –** Refuge chamber to include secondary breathing air cache in the form of medical grade or aviator style oxygen cylinders. Cache to be sized accordingly to provide minimum 0.02 cubic feet O_2 per minute, per occupant, for the intended entrapment duration of the refuge (per #3 above). Delivery should also be capable of being regulated to consistently maintain O_2 concentrations between 18.5%-23%.
7. **Carbon Dioxide Removal** – Refuge chamber to be equipped with CO_2 removal system capable of removing no less than 0.85 cubic feet CO_2 / hour / occupant for the intended entrapment duration of the refuge (per #3 above). System must be able to maintain CO_2 concentration at 1% or less within the chamber at all times. *Note: MSHA CFR 30 threshold is 1%.*
8. **Carbon Monoxide Removal** – Refuge chamber to include a carbon monoxide removal system, capable of maintaining CO levels below the maximum long term exposure limit of 30ppm within the chamber, for the intended duration (per #3 above).
9. **Cooling & Dehumidifying** – The refuge chamber shall include a cooling/dehumidifying system with minimum capacity of 400 BTU per occupant, for removal of moisture (humidity) and

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reduction of heat from multiple sources within the chamber (i.e.: metabolic heat, electrical equipment, air scrubbing, etc.).

10. **Atmospheric Monitoring** – Refuge chamber to be equipped with means of monitoring interior concentrations of oxygen (O_2), carbon dioxide (CO_2) and carbon monoxide (CO).

We trust that Cal/OSHSB will review available technologies, consider existing legislations elsewhere, and adopt a modern life saving platform of its own, for workers and visitors in underground tunneling operations throughout the state.

I look forward to presenting these recommended amendments at one of the board's upcoming public meetings, and am available to answer any questions you may have in the interim.

Thanks and regards,

Rob Frashefski
North American Sales Manager
MineARC Systems America LLC

MineARC® Systems

Tunnel Refuges

Designed to provide a refuge or 'safe-haven' for tunnel personnel trapped in a hazardous or toxic environment.

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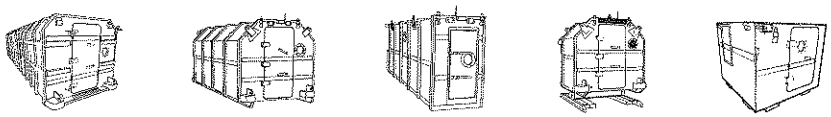
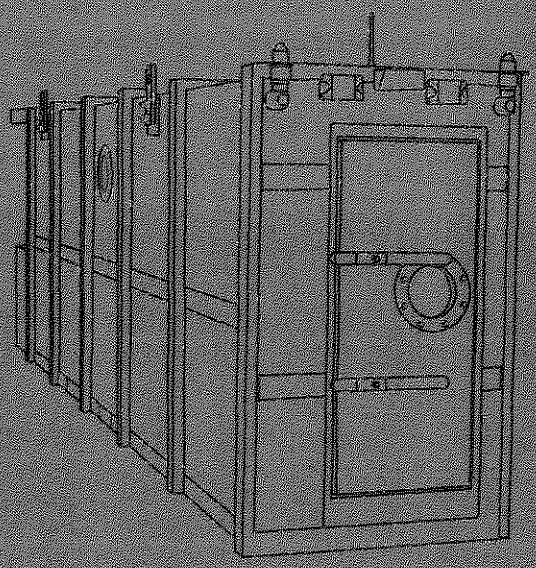


MineARC Systems - The world's leading manufacturer of emergency life-saving refuge

MineARC® Tunnel Refuge



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MineARC® Systems Company Profile

MineARC Systems is a global leader in the manufacture and supply of emergency safe-refuge to the underground mining, tunnelling, and chemical processing industries.

With over 15 years of experience, our dedication to ongoing research and development has kept us at the forefront of safe refuge technology.

MineARC refuges have been successfully used around the world in multiple mine and tunnelling emergencies to save lives. MineARC has offices and manufacturing facilities in Perth, Western Australia, Pretoria in South Africa, Santiago, Chile, Fushun in China and Dallas in the United States, as well as a strong distribution network worldwide.

In total, MineARC has manufactured refuges for mining, tunneling and chemical operations in over 25 countries.

All MineARC Refuges comply with the highest international industry regulations and guidelines.

MineARC is the only refuge manufacturer in the world with an ISO: 9001 quality rating. MineARC was named winner of the 2010 West Australian Exporter of the Year Awards.

www.minearc.com

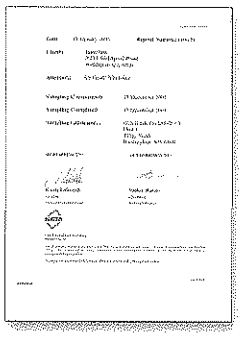
CE

European CE Certified to Machinery Norms

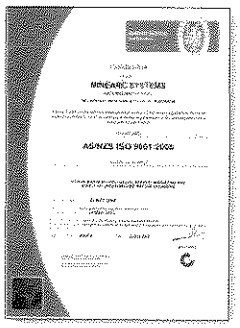
Australian C-Tick Standards: AS4100-1998, AS3570.1-18, AS2208, AS3000, AS1716-15

nec 2011

United States National Electrical Code (NEC) 2011



MineARC® HRM Refuge Live Risk Assessment Testing



Bureau Veritas ISO 9001:2008 Quality Management Systems

ISO 9001
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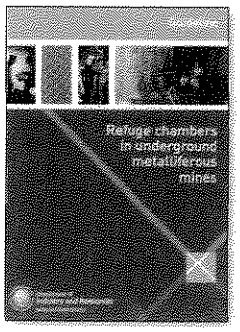
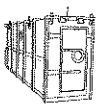
Certification



West Australian DMP Guidelines for Hard Rock Mines

48th AUSTRALIAN EXPORTAWARDS FINALIST

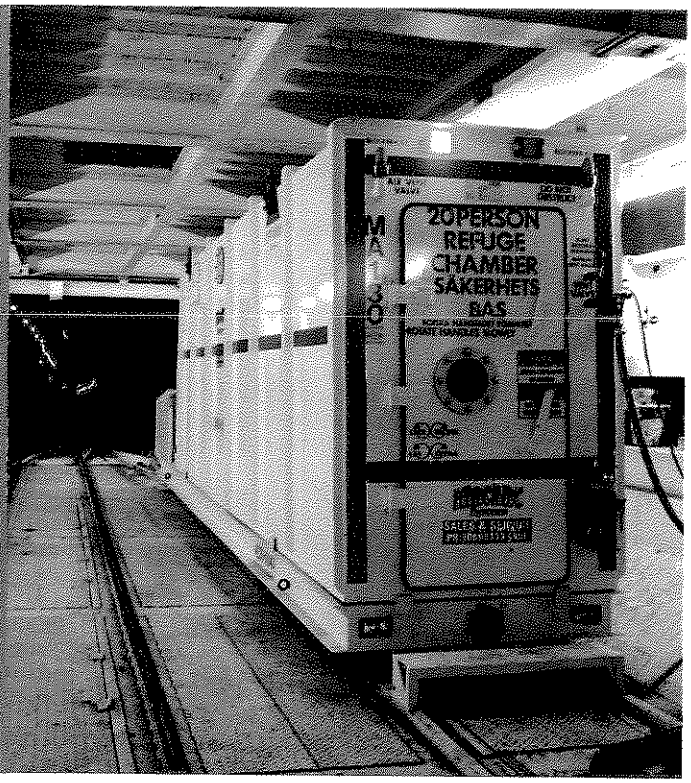


Recent MineARC Tunneling Projects:

- Dublin Port Project, **Ireland**
- Malmo-Gothenburg Rail Project, **Sweden**
- Niagara Fall Hydro Tunnel, **USA**
- Bunol High Speed Railway, **Spain**
- Brisbane North South Bypass, **Australia**
- Castle Peak, **Hong Kong**
- West Drainage, **Hong Kong**
- Brightwater Project, **USA**
- Yucca Mountain Project, **USA**
- Express Rail Link, **Hong Kong**

Major Contractors / Manufacturers Worked With:

- Nishimatsu
- Robbins
- Herrenknecht
- Dragages
- Bilfinger Berger
- Leightons



Why The Need for Refuge?

Emergency refuge forms an integral part of a tunnelling project's wider Emergency Response Plan (ERP). Fires, fall of ground, flooding, and the release of smoke and other forms of toxic gas are the types of incidents that can occur all too frequently, despite the high levels of planning and safety precautions in place.

In these types of emergencies, where personnel become trapped without adequate ventilation and/or when evacuation is no-longer safe or practical, emergency refuge is designed to provide a safe and secure 'go-to' area for personnel to gather and await extraction.

MineARC refuges have been successfully used around the world in multiple real-life mining and tunneling emergencies to save lives.

NEWS

Niagara tunnel fire proves TBM and

Local news

Tuesday 27th

Diversion Tu

contractor St

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successfully carried out e

yesterday's fire.

NEWS

Fire drama at Guadarrama

Tunnel Industry Case Studies:

Niagara Falls, United States 2010

A compressor fire during the construction of the Niagara Falls Diversion Tunnel Project in 2010 forced 30 personnel to seek shelter inside two standard portable MineARC Tunnel Refuges for over five hours. All personnel escaped unharmed, after sheltering inside until the smoke had cleared.

Guadarrama, Spain 2003

A locomotive caught on fire during the construction of the Guadarrama Rail Tunnel, Spain in 2003 trapping 34 workers between the tunnel entrance and the TBM cutting head. Fortunately on this occasion all escaped unharmed.

Refuge Chamber Configurations

TBM Method

Systems Integration

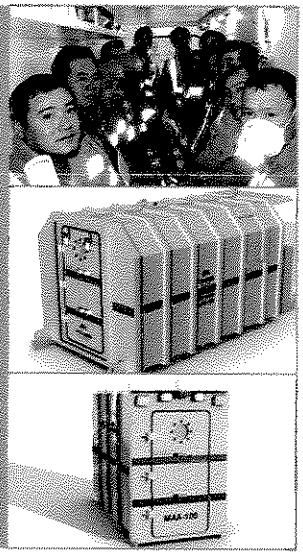
Emergency refuge should be considered within the broader context of an entire emergency response/management plan and in conjunction with a range of other important design/safety factors, including; overall tunnel design, ventilation systems, means of egress, emergency procedures and available tunnel rescue equipment.

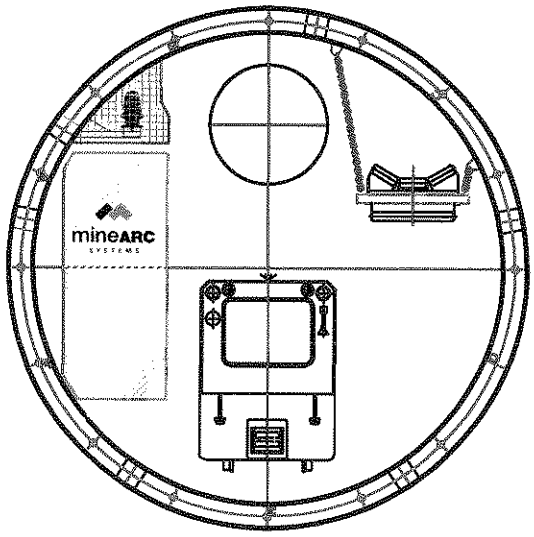
MineARC engineers are on hand during the entire design process to ensure the best possible safety solution is delivered for each and every project.

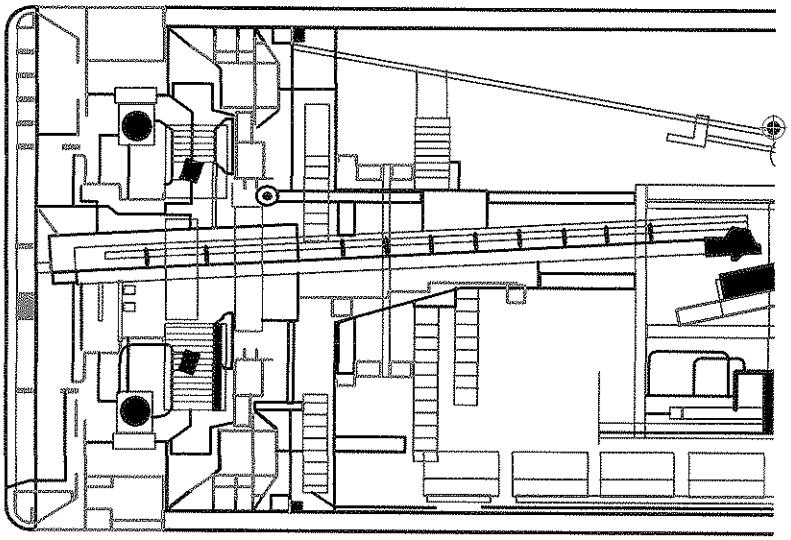
Custom Design

Virtually all aspects of an individual tunnel refuge's design can be customized by MineARC engineers, including; standard dimensions, structural integrity, internal volume, occupancy, entry airlock/vestibule and minimum entrapment durations.

MineARC can also engineer the refuge to double as a control room, office area or rest station.





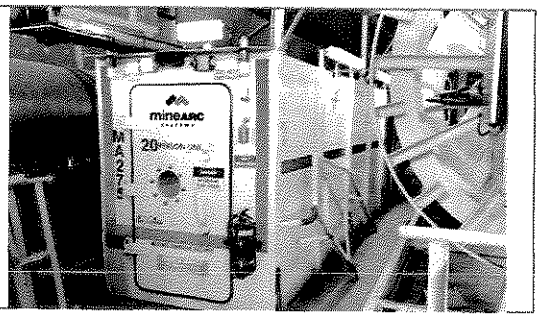


MineARC TBM Gantry Mounted Refuge Chamber

TBM Gantry Mounted Refuge

Providing safety at the rear of the cutting head infrastructure, MineARC's TBM gantry mounted refuge offers premium safety features, regardless of size constraints.

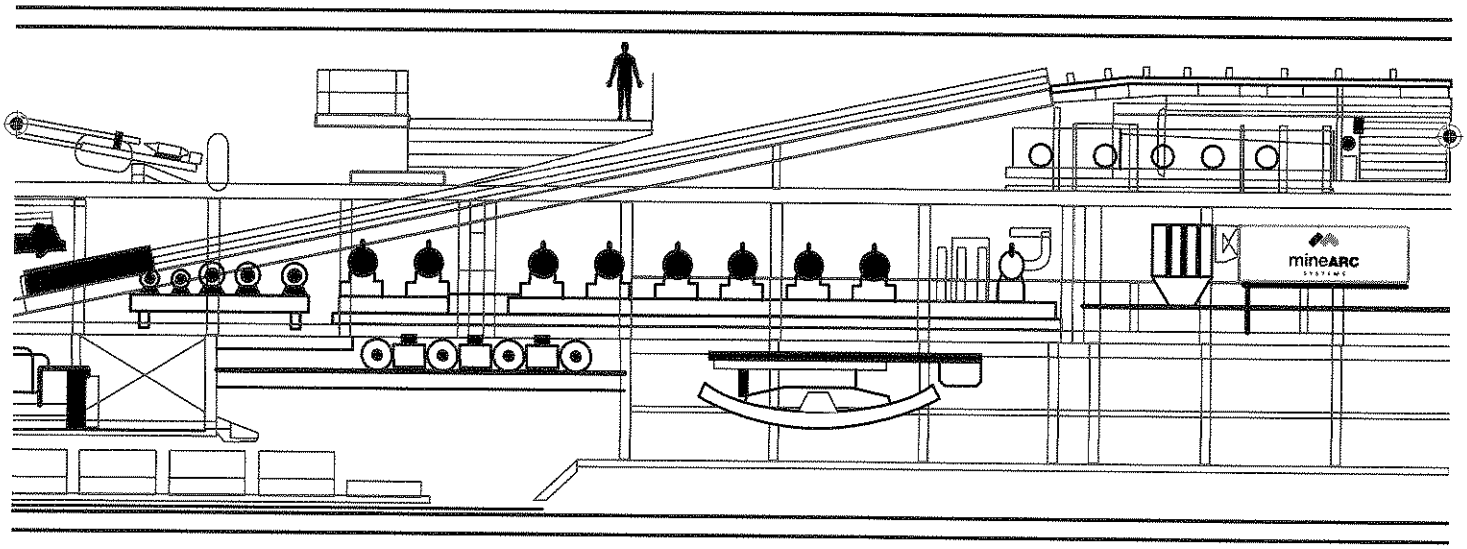
MineARC engineers can custom design and manufacture each TBM refuge to meet a project's specific needs, without compromising on occupancy potential or safety.



Rail Mounted Tunnel Refuge (Post Construction)

MineARC can custom design and manufacture various refuge models that can be rail mounted, towable or permanently located at the rear of the tunnel, serving as a safe haven for workers during routine inspections and/or maintenance works.

As a long term safety option for the life of the tunnel, the chambers are robust and fully serviceable. All refuges can be fitted with remote controls and remote monitoring systems.

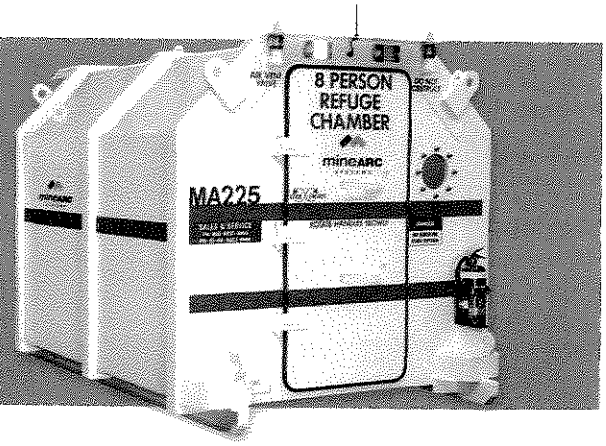


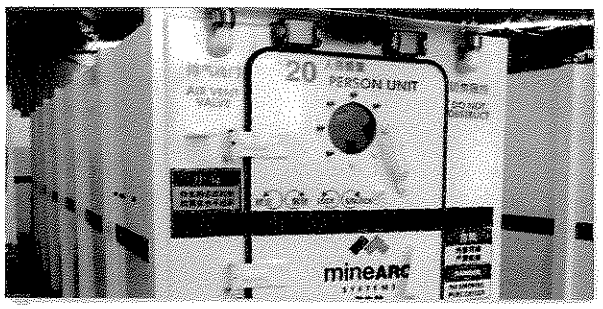
Standard Portable Tunnel Refuge

MineARC's standard portable refuge models can be used in the tunnelling industry where size constraints are not as restrictive. These units can accommodate up to 26 people and are ideal for tunnelling applications involving cross cuts or maintenance areas, as well as drill and blast projects.

In an emergency situation, these areas serve as an effective escape area for personnel working behind the TBM or adjacent to feeder tunnels.

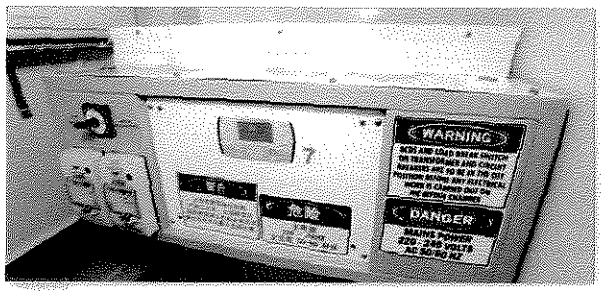
MineARC Portable Refuges feature all of the same vital life support systems as TBM mounted or rail mounted refuges.





Construction

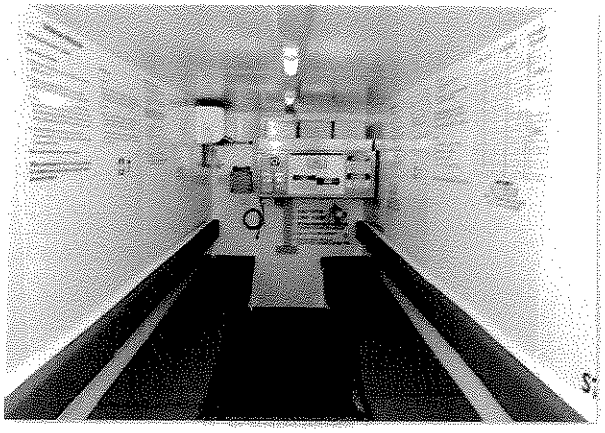
MineARC's Tunnel Refuge has been meticulously engineered to ensure ease of transport and a robust design. Constructed from 5mm (1/4") steel plate with external steel support wraps as standard, the refuge also comes equipped with lifting lugs and forklift slots to the sides.



CO/CO_2 Scrubbing with DGM

MineARC's Tunnel Refuge uses active chemicals and MineARC's patented scrubbing system to remove the buildup of harmful CO_2 (carbon dioxide) and CO (carbon monoxide) gas from inside the refuge as the occupants expire the air.

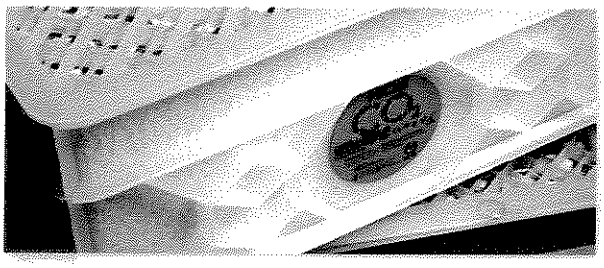
The refuge's gas monitoring systems continuously monitor and alert occupants to the internal levels of CO_2, O_2 (oxygen) and CO. Gas monitoring systems can be customised to onsite requirements.



Oxygen Supply and Air Conditioning

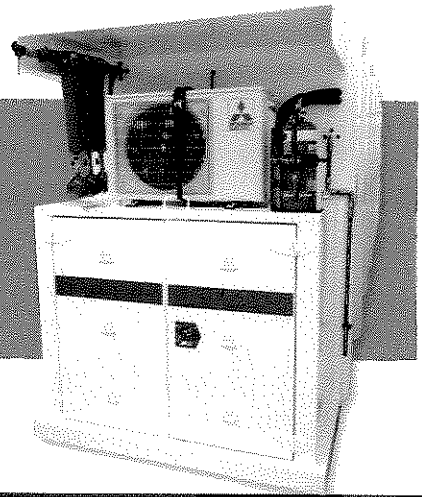
Every MineARC Tunnel Refuge is equipped with 3 separate sources of air supply. Under normal circumstances tunnel refuges should be connected to external (mains) air supply or ventilation (1). However, should this connection become severed or contaminated, medical grade oxygen cylinders (2) and oxygen candles (3) will continue to supply breathable air to the refuge for a minimum of 12hrs.

Air conditioning is vital to combat the potentially fatal affects of heat stress; caused by the build-up in each occupant's own metabolic activity, as well as any transient (external) heat affecting the refuge's internal temperature. All MineARC Tunnel Refuge's are therefore fitted with quality reverse cycle air conditioners.



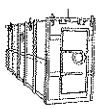
Service and Maintenance

MineARC Refuges are easy to inspect and maintain, performing their own electrical checks whilst requiring minimal general preventative maintenance. The refuge also has a low ongoing cost of ownership, with consumables (such as the active chemicals used in the scrubbing system) having extended shelf lives.



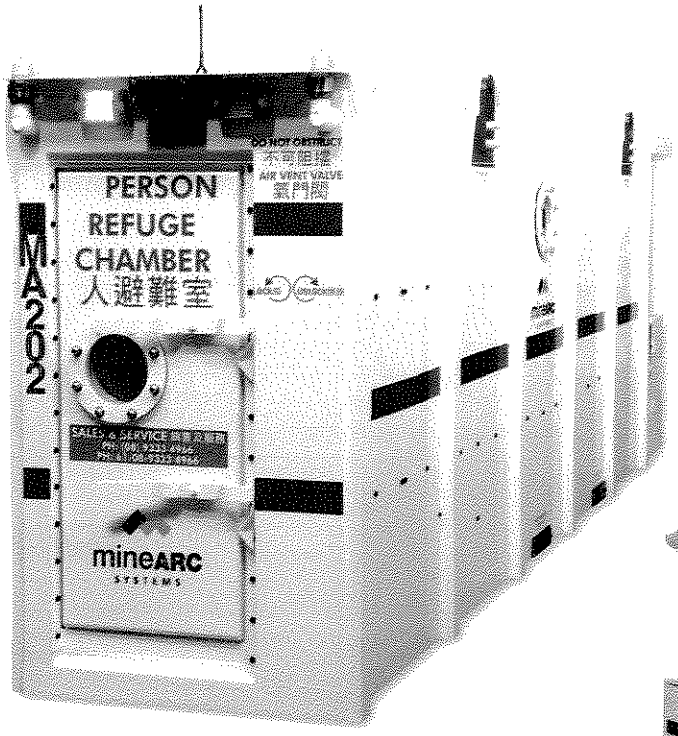
Battery Back-Up (UPS)

MineARC Tunnel Refuges are designed to run off a project's 'mains' electrical power supply, operating indefinitely once connected. However, in the event that mains power is lost, the refuge is equipped with its own battery UPS (Uninterruptable Power Supply), capable of powering all internal life support systems for a minimum of 12hrs, stand-alone.



Features Summary

MineARC® Tunnel Refuge



- **5mm (1/4")** Steel Plate Construction
- **3 Sources** of Air Supply
- **CO & CO_2 Scrubbing**
- **Digital Gas Monitoring**
- **Air-Conditioning**
- **12hrs** Minimum Stand-Alone Duration
- **Optional 15PSI** Blast Resistance

STANDARD FEATURES

- 5mm (1/4") Steel Plate Construction
- 3 Sources of Air (Oxygen) Supply
- Carbon Dioxide (CO_2) and Carbon Monoxide (CO) Scrubbing with Digital Control System
- Air Conditioning and Dehumidifying
- Fire Resistance
- Battery Back-UPS 12hrs Minimum Life Support
- Digital Gas Monitoring (DGM)
- Viewing Portal
- Rear Escape Hatch
- Ergonomically Designed Seating
- Lifting and Towing Lugs
- Forklift Slots
- Non-Slip Flooring
- Chemical Toilet
- Internal and External Fire Extinguishers

OPTIONAL FEATURES

- Special Transport Configurations (Rail Mounted, Remote Control Operation, Raised Skid Base)
- Internal Office Space / Rest Area Configuration
- Separate Air Lock / Vestibule Entry Compartment
- 15 PSI Explosion Proof Construction
- Battery Back-UPS Upgrade to 24hrs
- Remote Internal Video Monitoring
- First Aid Kit (Standard on US Models)
- Step-Down Transformer

mineARC
SYSTEMS

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