Tunnelling

Refuge Chambers

Designed to provide a refuge or ‘safe-haven’ for tunnel personnel trapped in a hazardous or toxic environment.
MineARC Systems is the global leader in the manufacture and supply of emergency safe refuge solutions for the mining, tunnelling, chemical processing and disaster relief industries.

With over 15 years’ experience, our dedication to ongoing research and development is driven by our key focus to continually offer the best and most advanced safety solutions on the market.

Our team of qualified engineers, electrical designers and technical experts form a global network across six international locations including:

- Perth, Western Australia
- Johannesburg, South Africa
- Dallas, Texas
- Santiago, Chile
- Beijing, China
- Barcelona, Spain

This allows MineARC to provide 24 hour service and engineering support to our expanding list of clients in over 40 countries across the globe.

All MineARC Refuge Chambers and Safe Havens comply with the highest international regulations and recognised ‘world’s best practice’ industry guidelines. Our key focus on quality control and product advancement has meant that MineARC Refuge Chambers have successfully saved lives in multiple real life industrial emergencies around the globe.

www.minearc.com
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 evacuation is no longer safe or practical, emergency refuge is designed to provide a secure ‘go-to’ area for personnel to gather and await extraction.

MineARC Refuge Chambers have been successfully used around the world in multiple real-life tunnelling emergencies to save lives.

MineARC’s TunnelSAFE Range of Refuge Chambers are highly customisable to suit any project and can be built to comply with British Standard (BS EN 16191:2014) Safety Requirements for Tunnelling Machinery.

They can also comply with the ITA’s “Guidelines for the Provision of Refuge Chambers Under Construction”. 
Regardless of size constraints, MineARC Engineers can custom design and manufacture each refuge chamber to meet the specific needs of the project, without compromising on occupancy potential or safety features.

**Features**

- Designed specifically to be mounted on a tunnel boring machine
- ELV CO and CO2 scrubbing
- Medical O2 regulator and backup
- Positive pressure maintenance system with visual reference
- Audio visual warning for pneumatic disruption
- Guardian Remote Monitoring and Diagnostics System
- Aura-FX Digital Gas Monitoring
- Air conditioning and dehumidifying
- 5mm steel plate construction with reflective signage
- Water based fire extinguisher (optional for non-Australian orders)
- Full UPS 24hr battery backup system
- Ergonomically designed seating
- Radio power supply
- External strobe lighting; internal fluorescent lighting

**Standard Configurations**

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*Indicative weights only. Custom variations will impact final refuge chamber weight.
Optional: EnviroLAV Waste Management System

Also available is the electrically powered EnviroLAV Waste Management System that can be positioned at the rear of the TBM gantry, allowing for quick and simple installation and service on site.

The Compact model EnviroLAV features a small footprint of less than 1.5m²; an ideal size for the tight confines of the TBM where space is a limiting factor. Removable steps allow for further maximisation of space.

The EnviroLAV’s unique waste breakdown process reduces emptying requirements to just once per year based on standard usage.

For more information please visit www.minearc.com/EnviroLAV
MineARC® Systems

TunnelSAFE Rail Design

Refuge Chambers can also be fitted with remote monitoring systems, or the client’s own remote control system. MineARC offers full after-market care for refuge chambers, from commissioning to on-site servicing and training.

TunnelSAFE Rail Design Refuge Chambers can also be fitted with remote monitoring systems, or the client’s own remote control system. MineARC offers full after-market care for refuge chambers, from commissioning to on-site servicing and training.

Features

- Designed specifically to be mounted on a rail trolley or rescue train
- ELV CO and CO₂ scrubbing
- Medical O₂ regulator and backup
- Positive pressure maintenance system with visual reference
- Audio visual warning for pneumatic disruption
- Aura-FX Digital Gas Monitoring
- Air conditioning and dehumidifying

- 5mm steel plate construction with reflective signage
- Water based fire extinguisher (optional for non-Australian orders)
- Full UPS 24hr battery backup system
- Ergonomically designed seating
- Radio power supply
- External strobe lighting; internal fluorescent lighting

Standard Configurations

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*Indicative weights only. Custom variations will impact final refuge chamber weight.
STROBE LIGHTING
- Extra low voltage
- Green & red LED

SIREN
- 112 dBA

DRIVER WINDOW
- AS 2208
- Blast resistant upon request

PAINT
- Sand blasted to 2.5 grit

SEALING DOOR
- Outward opening
- Vacuum tested seal
- Double locking rotating handles

REFLECTIVE SIGNAGE
- Safety & operational
- Optional extra: Multiple languages

Chamber Exterior - Front
MineARC can custom engineer and manufacture refuge chambers to be mounted on a multi-service vehicle; providing a portable safe haven for workers during routine tunnel inspections and maintenance works. As a long term safety option for the entire life of the tunnel, these chambers are robust and fully serviceable.

TunnelSAFE MSV Design Refuge Chambers can also be fitted with remote monitoring systems, or the client’s own remote control system.

**Features**

- Designed specifically to be mounted on a multi-service vehicle
- ELV CO and CO2 scrubbing
- Medical O2 regulator and backup
- Positive pressure maintenance system with visual reference
- Audio visual warning for pneumatic disruption
- Aura-FX Digital Gas Monitoring
- Air conditioning and dehumidifying

- 5mm steel plate construction with reflective signage
- Water based fire extinguisher (optional for non-Australian orders)
- Full UPS 24hr battery backup system
- Ergonomically designed seating
- Radio power supply
- External strobe lighting; internal fluorescent lighting

ITA or BS EN 16191 compliant models available
REFLECTIVE SIGNAGE
- Safety & operational
- Optional extra: Multiple languages

DRIVER WINDOW
- AS 2208
- Blast resistant upon request

SEALING DOOR
- Outward opening
- Vacuum tested seal

INSULATED FLOORING (OPTIONAL)

DRIVER CONTROL PANEL CONNECTION

ROTATING HANDLES
- Double locking

TÜRGRIFF

HANDLE
For drill and blast tunnelling operations, MineARC has developed a standard range of portable refuge chambers that can be positioned and repositioned with ease, providing an ongoing safety solution for the life of the project.

They offer an ideal solution for projects involving feeder tunnels and single-entry development headings, including sub-surface railway stations, hydro-power stations and other complex tunnel networks.

**Features**

- Self-regenerative ELV CO and CO2 scrubbing
- Medical O2 regulator and backup
- Compressed Air Management System (CAMS)
- Positive pressure maintenance system with visual reference
- Audio visual warning for pneumatic disruption
- GuardIAN Remote Monitoring and Diagnostics System
- Aura-FX Digital Gas Monitoring
- Air conditioning and dehumidifying
- 5mm steel plate construction with reflective signage
- Water based fire extinguisher (optional for non-Australian orders)
- Full UPS 24hr battery backup system
- Ergonomically designed seating
- Radio power supply
- External strobe lighting; internal fluorescent lighting

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*Indicative weights only. Custom variations will impact final refuge chamber weight.
AIR CONDITIONING SYSTEM
- R410a refrigerant cooling
- UL listed Mitsubishi Split System

AIR CONDITIONING RUN AT 30° (86°F) ON BATTERY ONLY

OXYGEN SUPPLY #2:
MEDICAL GRADE OXYGEN CYLINDERS (Not pictured)
- Minimum capacity based on G size cylinder (8,580L); quantity required outlined below:

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*Medical grade Oxygen cylinders to be provided by end user.

OPTIONAL: OXYGEN SUPPLY #3:
OXYGEN CANDLE KIT (Not pictured)
- 2,600L oxygen produced / 60 mins ignition; Military approved
- Supplied separately as Dangerous Goods

Optional: Standing Room Only
Designed for high personnel volume requirements.
Inside a MineARC TunnelSAFE Refuge Chamber, a number of vital life support systems combine to create a safe, ongoing environment for occupants. Systems include primary and secondary oxygen supplies, air conditioning and dehumidifying, positive pressure maintenance, electrical and communications, gas detection and CO/CO₂ absorption (referred to as ‘scrubbing’ systems).

MineARC TunnelSAFE Chambers use active chemicals and MineARC’s Extra-Low-Voltage (ELV) Scrubbing System to ‘scrub’ the build-up of harmful CO₂ and CO from the air inside the refuge chamber.

In high enough concentrations, both CO₂ and CO can cause serious injury leading to a loss of consciousness and eventually, death. CO₂ and CO are expired by occupants as part of their normal breathing activity. Carbon Monoxide can also enter the main chamber via the compressed air intake (if it becomes compromised), and as occupants enter and/or exit the main entrance, making CO/CO₂ scrubbing a vital necessity.

Air Conditioning

Air conditioning is vital to combat the potentially fatal effects of heat stress; caused by a build-up in occupant’s own metabolic activity, as well as any ambient (external) heat affecting the refuge chamber’s internal temperature.

Extra-Low-Voltage Controller Interface

The controller interface is the operational hub of the refuge chamber. From here, all power, lighting and scrubbing can be managed with the flick of a switch.

MARCISORB Chemical Cartridges

The ELV scrubbing system utilises pre-packaged MARCISORB chemical absorber cartridges. MineARC’s MARCISORB CO and MARCISORB CO₂ cartridges provide superior scrubbing capacity, are easy to load, safe to handle, and can store for long periods.
GuardIAN Remote Monitoring & Diagnostics System

MineARC’s GuardIAN Remote Monitoring and Diagnostics System is an exciting new development in refuge chamber technology. GuardIAN enables real-time monitoring; providing confidence that an operation’s fleet of refuge chambers are emergency ready at all times.

GuardIAN is an on-board system that continuously monitors all vital refuge operating systems. During standby mode GuardIAN checks for component faults and monitors refuge chamber usage or entry to the chamber.

GuardIAN’s secure online interface is hosted on an internal server within the refuge chamber so that no client software installation is required. The responsive webpage is easily accessible from any computer, tablet or smartphone and features a summary of your entire refuge chamber fleet and overall operational status, with the ability to drill down to a detailed report of each chamber.

GuardIAN is a standard feature of the TunnelSAFE Drill & Blast and Gantry Design ranges. It is also available as an option for the TunnelSAFE Rail and MSV Design ranges.

**Improves Operational Safety:**
- Operational communication during emergency use
- Direct video and gas monitoring for evacuation planning
- Greater system automation for reduced risk of human error
- Centralised diagnostics and analysis of entire MineARC Refuge Chamber fleet via computer, tablet or smartphone
- Programmable push email notifications for important refuge chamber events
- Voice prompting gas monitoring for chemical change-out and oxygen regulation
- Air toxicity shut off prevents smoke and carbon monoxide ingress via the compressed airline
- Increased monitoring ensures all critical components remain in the chamber
- Reduced ‘out-of-service’ time for all refuge chambers
- Eliminates chamber misuse

**Reduces Operational Costs:**
- Reduced servicing time
- Real-time troubleshooting, reducing maintenance staff down-time
- Advanced maintenance planning
- Extended calibration periods for gas monitoring
- Reduced gas sensor replacement costs
- Extended sensor life
- Faster and easier sensor replacement
- Lower energy costs through the optimisation of mine air usage
- Flood protection, eliminating costly chamber refurbishment
- Reduction in replacement parts due to theft
- Reduced service kit costs
- Streamlined purchasing process
Live video streaming can greatly assist in evacuation planning during an emergency; providing the capability to determine the capacity of the refuge chamber and monitor the well-being of occupants. Internal video monitoring is provided by a remote controlled, motion activated GuardIAN IP camera. When activated, the camera will send out a live, recorded stream of the interior of the refuge chamber. External video monitoring is also available as an optional upgrade to the GuardIAN System.

To assist occupants during an emergency or safety drill, GuardIAN also equips your refuge chamber with a VOIP video phone. This facilitates face-to-face communication between the refuge chamber and the surface; improving the psychological well-being of chamber occupants during an emergency, providing assistance to perform any difficult or technical procedures and facilitating face-to-face trouble shooting for service staff in order to reduce the need for multiple surface visits during a maintenance run.

GuardIAN Live Video Monitoring and VOIP Video Phone

MineARC’s new Aura-FX Digital Gas Monitoring System is a proprietary fixed gas monitoring unit, designed specifically for use in MineARC refuge chambers and safe havens. A vast improvement on current digital gas monitors (DGMs) on the market, Aura-FX provides a refuge chamber specific solution to gas monitoring. Aura-FX has the ability to individually monitor up to 11 gases via a series of user-friendly, digital screens. Audible voice alarms will prompt occupants to replace scrubbing chemicals or adjust oxygen supply levels in the refuge chamber as required.

When utilised as part of the MineARC System Intelligence network, Aura-FX provides real-time gas monitoring data and analysis via the GuardIAN dashboard.

Aura-FX-CM (Compact Model) is a standard feature of the TunnelSAFE range and can monitor three gases at any one time.

Aura-FX Digital Gas Monitoring Diagnostics

MineARC’s Digital Controller links directly to GuardIAN, streaming real-time system data to a surface control room(s). Data includes automated system checks, battery fault logging, system diagnostics, internal and external temperature measurements, and system actions such as scrubber activation.

System faults, events and scheduled service notifications can be sent to designated personnel as email alerts; notifying them of upcoming service requirements, potential emergencies or mal-use as they occur.

GuardIAN System Monitoring, Event Logging and Fault Diagnostics

Compressed Air Management System Diagnostics

The MineARC Compressed Air Management System (CAMS) is a dedicated air management unit designed specifically for use in refuge chambers. The unique air management system monitors and regulates compressed air flow into the chamber. When utilised as part of the MineARC System Intelligence network, vital information relating to the integrity of the internal refuge chamber atmosphere is communicated in real-time via the GuardIAN dashboard. An increase in CAMS activity would indicate a breach of the refuge chamber seal, thus sending an alert to designated personnel that the chamber is compromised.

CAMS is a standard feature of the TunnelSAFE Drill & Blast range. It is also available as an option for the TunnelSAFE Gantry, Rail and MSV Design ranges.
MineARC pressure systems are designed to help maintain a safe, breathable atmosphere within the refuge chamber. Systems include the Pressurised Access Safety System (PASS) to ensure safe entry into the refuge chamber, and the Positive Pressure Maintenance System (PPMS) to maintain positive internal pressure within the chamber.

**Pressurised Access Safety System**

The Pressurised Access Safety System (PASS) remote activation unit is located next to the door on the front exterior of the refuge, allowing personnel to pre-prepare the chamber for safe entry.

Should the chamber’s fresh compressed air supply be disconnected or compromised, the system’s external LED light will display red, indicating that the chamber is not positively pressurised and therefore unsafe for entry.

Once activated, the PASS will disperse controlled quantities of compressed air into the chamber until the internal pressure reaches 200 Pa. By ensuring that the pressure inside the refuge is slightly greater than outside, toxic contaminants are prevented from infiltrating the chamber during entry of personnel.

**Positive Pressure Maintenance System**

The Positive Pressure Maintenance System (PPMS) enclosure is securely mounted to the interior wall of the refuge chamber. Powered by a 24VDC power supply, the electric solenoid valve opens and closes to release measured amounts of breathable air from compressed air cylinders in order to maintain a positive internal pressure.

The quantity of compressed breathable air cylinders is configurable to suit various internal volumes and durations of operation.
A secure cabinet at the rear of the TunnelSAFE houses the refuge chamber’s UPS battery back up (Uninterruptible Power Supply). The UPS is a fail-safe system that can power the refuge chamber’s internal life support systems for a minimum of 24hrs, should mine power become cut-off.

The Compressed Air Management System (CAMS) allows regulated compressed air into the refuge chamber when the pressure inside drops below 200Pa. This process optimises mine air usage and guarantees against over-pressurisation of the refuge chamber. CAMS' gas toxicity monitor automatically diverts compressed air if oxygen levels in the airline fall below a set level (18% oxygen in free air), signifying air contamination. Additionally, the incorporated flood protection valve automatically shuts down compressed air to avoid catastrophic and costly chamber damage in the event of water ingress.

Optional: Satellite UPS System

MineARC’s Satellite UPS System has been engineered specifically for use in conjunction with refuge chambers; designed to ensure batteries perform at full capacity for their expected life span.

By ensuring atmospheric conditions are optimal, monitoring battery activity and adding electronics to the charging system, the Satellite UPS System limits all primary aspects of battery degradation and allows MineARC’s high quality batteries to operate as intended.

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

Virtually all aspects of a MineARC TunnelSAFE Chamber design can be customised by MineARC Engineers, including; shape, standard dimensions, blast resistance, internal features, occupancy, entry airlock/vestibule and minimum entrapment durations. MineARC can also engineer the refuge chamber to double as a control room, office area, rest station or blast room (used in drill and blast operations).

Misting System

To combat potentially high ambient temperatures on-site, MineARC has developed a unique, self-contained misting system that is available as an optional upgrade on all TunnelSAFE Refuge Chambers.

The system assists in heat suppression of the external environment by emitting a fine mist of water around the exterior of the chamber. The mist is set to a droplet size that will flash evaporate under high temperatures, creating a temperature barrier around the chamber which, in turn, maintains a life-sustainable internal environment. The water supply tank is generally integrated into the refuge chamber floor or beneath the seats, and is activated via an internal control switch.

Permanent Refuge Solutions

45° Angle Front Entry

Auto-Retracting Seating
**Feature Summary**

**Industry Compliance**  ITA or BS EN 16191

- **5mm (1/4") Steel Plate Construction**
- **Breathable Air Supply**
- **CO & CO₂ Scrubbing**
- **Aura-FX Digital Gas Monitoring**
- **GuardIAN Monitoring** (available for some models)
- **Air-Conditioning**
- **Stand Alone Battery UPS**
- **PPMS & PASS**

**Options**

- Custom dimensions and transport configurations
- Blast shield protection (reinforced construction)
- Fully flushing, pressurised airlock
- Misting system for external temperature control
- Battery backup UPS upgrade
- First aid kit

- Internal LCD monitor screen
- Step-down transformer
- Carbon Monoxide Safety-Off-System (COSOS)
- Remote video camera monitoring
- Intrinsically safe MARCis Scrubber
- Automated Oxygen Delivery System (AODS)

**TBM/Mobile Configurations**

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**Drill & Blast Configurations**

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MineARC® Systems

The world’s leading manufacturer of emergency life-saving refuge

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