

**Workplace Safety North**

**Health and Safety Report**

# **Mine Rescue Refuge Station Report**

**December 2016**



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# Refuge Station Report

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## **Introduction**

In 1930, two years following the Hollinger Fire that claimed the lives of 39 miners who could find no safe refuge from the carbon monoxide created by the fire, the Mining Act was amended to include the provision of refuge stations where the Chief Inspector of Mines deemed necessary. Refuge stations were to “have water, air, telephone connections to surface and be separated from adjoining workings by closeable openings so arranged and equipped that gases can be prevented from entering.”

The intent was to create a safe refuge to protect and sustain life in the event of an underground fire by providing a source of respirable air, and preventing contamination by carbon monoxide and other gases produced by the fire. The value of refuge stations has since been demonstrated in other jurisdictions in non-fire emergencies, where they have provided shelter and resources during falls of ground and in-rush of water.

Though the legislated specifics for refuge stations have been added to and amended in the years since, the intent for refuge stations to save lives remains unchanged. Ontario mining operations vary substantially in size, location, mining technique, and complexity of operation. This report is intended to provide information to assist operations to enhance the minimum requirements for refuge stations required under the Occupational Health and Safety Act, and Regulation 854: Mines and Mining Plants.

## **Purpose**

A refuge station is a place of relative safety in an underground mine during an emergency where workers can be provided with basic life support, including a source of respirable air and potable water, until rescued or it is safe to exit the mine.

The primary emergency scenario in which workers may need a refuge station is when they are exposed to smoke and atmospheric contamination from a fire, or other cause of an irrespirable atmosphere (gas release, loss of ventilation). Other emergency scenarios exist, however, such as falls of ground, in-rush of water, and events in which egress may not be possible and workers will depend on a refuge station as a safe haven.

In some operations, a refuge station may serve an ancillary purpose, such as an office, first aid station, training area, break or lunch room or other service, but the primary function of a refuge station to support and maintain life during emergency situations must never be compromised.

## Legislative Requirements

### Occupational Health and Safety Act

#### Reg. 854: Mines and Mining Plants

**Section 26** — Where the procedure in case of a fire in an underground mine provides for the use of a refuge station for workers, the **refuge station** shall,

- (a) be constructed with materials having at least a one hour fire-resistance rating;
- (b) be of sufficient size to accommodate the workers to be assembled therein;
- (c) be capable of being sealed to prevent the entry of gases;
- (d) have a means of voice communication with the surface; and
- (e) be equipped with a means for the supply of,
  - (i) compressed air, and
  - (ii) potable water. R.R.O. 1990, Reg. 854, s. 26.

**Section 120** — (1) A service garage, service bay or fuelling station in an underground mine shall, . . .

- (b) be located so that in the event of a fire or explosion in the garage, bay or station there will be a minimum effect on working areas of the mine or on underground installations including shafts, magazines, **refuge stations**, transformer installations and other installations; . . .

**Section 126** — (1) A magazine, storage container or explosive storage area referred to in Section 125 that is in an underground mine shall be,

- (a) located at least 60 metres from, . . .
  - (iii) **areas of refuge** or other areas where workers may congregate, and

**Section 135** — (1) Where explosives are transported underground by means of a motor vehicle or a train, . . .

135.0.1 (1) . . .

(4) A place may be designated as a safe parking place for the purpose of subsection (3) only if it is located at least 60 metres away from, . . .

- (c) **areas of refuge** or other areas where workers may congregate; and

**Section 233** — (1) A system for communicating by voice shall be installed and maintained at an underground mine. R.R.O. 1990, Reg. 854, s. 233 (1). . . .

(2) The communication system required by subsection (1) shall permit communication between persons at, . . .

(d) **an underground refuge station;** and

(e) an attended place on surface.

## **Risk Assessment**

Refuge stations play a vital role in emergency response in an underground mine and in the immediate safety of underground workers during an emergency. Refuge stations should always be considered when:

- Developing a new mine or re-entering an old mine
- Developing new levels
- Mining in an area remote from the normal access route into the mine
- An escapeway or secondary means of egress from the mine is not available
- When the time required for workers to evacuate via normal access routes may be excessive.

Most refuge stations are established once initial development is well underway. Until they are established and commissioned, interim procedures, such as the use of self-contained self-rescuers or fresh air tents, must be in place in the event an emergency occurs.

The effectiveness of a refuge station is based on a number of factors, including:

- Where the refuge station is located
- The number of people who may occupy the refuge station
- The physical size of the refuge station
- The time required to control the incident or rescue the occupants
- The design (including services provided) of the refuge station.

Ensuring the refuge station can meet the needs of an operation or a location within an operation, requires a complete assessment of the risks faced by workers in the vicinity of the refuge station, as well as the risks faced by the workers should they need to occupy the refuge station.

The objective is not just to identify and assess the risks related to the use of a refuge station during an emergency, but also to identify and prioritize controls to reduce the likelihood and/or eliminate or reduce the consequences of an incident involving the use of a refuge station.

Items to reference in a risk assessment include, but are not limited to:

- Distance to working area
- Distance to egress
- Work activities
- Number of workers in vicinity
- Major hazards
- Mining methods
- Ventilation

- Travel conditions
- Site and level specific conditions and requirements
- Communications.

## **Strategic Location and Access**

### **General Access**

Refuge stations should be located where the ground is safe and well-supported, and on main or normal routes of travel to provide ready access to workers in the vicinity and to mine rescue teams. Where at all possible, refuge stations should be located in fresh air, rather than return air, or as close as possible to fresh air.

The placement of a refuge station in a modern trackless mine should take into account the need for vehicle access. Vehicles and equipment should never restrict access to a refuge station. There have been international reports of rescue teams arriving at a refuge station only to find the route blocked with vehicles abandoned by the occupants in need of rescue.

Site layout, including level terrain and the positioning of features such as lighting and restricting bollards, should ensure easy access to and adequate protection of the station. It is also important that the workforce is completely familiar with the discipline and rules associated with maintaining effective access to the refuge station, and provided the reasons why such rules exist.

### **Exposure to Hazards**

A refuge station is perceived as a place of safety in an underground emergency. Its location should therefore be as secure from hazards as possible. Although the positioning of a refuge station is strongly governed by its accessibility to workers in need of its protection, any potential susceptibility of its location to the hazards of:

- Fire
- Blasting
- Explosion
- Airborne contaminants
- Fall of ground
- In-rush of water
- Damage from mine vehicles
- Geotechnical stability and seismicity

should also be considered.

The placement of refuge stations close to installations such as explosives magazines and fuel storage facilities is prohibited by legislation but other installations, such as transformer stations, garages, mono-pumps or vehicle parking bays should also be avoided because they are potential fire sources.

## Distance from Working Areas

Refuge stations should be located near active working areas, taking into account the needs of people working in the area and the potential hazards they face. As fire is the most common incident that leads to the use of a refuge station, and as the initial problem in the event of a fire is securing an immediate supply of respirable air, the use of self-contained self-rescuers (SCSR) is encouraged, and should be considered as a potential control measure in a comprehensive risk assessment.

**Maximum Safe Distance** — Though the maximum distance separating an active working area from a refuge station should be determined by a comprehensive risk assessment, it is recommended that 30 minutes be the maximum time required for a worker travelling at a moderate walking pace to reach the nearest refuge station. A shorter travel time may be advisable.

Travel distance and time may be adversely affected by factors such as:

- The worker's physical condition (e.g. fitness, age, medical conditions, fatigue, agitation)
- Physical challenges encountered (e.g. gradient, negotiating ladderways, climbing escapeways)
- Environmental conditions (e.g. temperature, humidity, airborne contaminants)
- Reduced visibility which may necessitate workers to crouch low or even crawl
- Mine ventilation practices which may ease or exacerbate the situation with respect to smoke and fumes.

**Minimum Safe Distance** — Similarly, a comprehensive risk assessment should be used to determine the minimum safe distance for the location of a refuge station near an active working area, taking into account the potential for:

- Entrapment
- Obstruction to work
- Exposure to radiated and convection heat from an underground fire
- Fall of ground, geotechnical stability and seismicity
- Damage from mine vehicles
- Damage from the effects of blasting.

## **Inundations**

A refuge station should not be placed in a location where in-rush of water or inundation of muck or tailings would adversely affect its operation during an emergency. Nor should a refuge station be placed in a location where water over time can collect in sufficient quantities to pose a risk to workers. Where that possibility exists, the control group must be made aware of the situation, and communications with the refuge station should be a priority.

## **Design, Construction, Fittings**

### **Type**

Different types of refuge station, including variations in size, can be used in an operation, and should be determined by a comprehensive risk assessment and mine layout.

**Permanent Refuge Stations** — Permanent refuge stations are excavated in competent rock, and must be constructed of materials with a one-hour fire resistance rating, that is they resist burning and withstand heat. Permanent refuge stations should also be constructed of materials that are fire retardant, that is they burn slowly, providing an extra layer of protection. Fire retardant construction materials include concrete, steel and bricks. Joints, cracks or fissures in the walls with possible connection to the mine environment should be sealed. Service lines through a wall should be sealed. Fluid discharge and drainage pipes, including a floor drain must have P-traps to prevent the ingress of gases. When in use, a permanent refuge station must remain totally sealed off from the surrounding atmosphere.

Permanent refuge stations are serviced with full complement of water, toilet, seating, communication, tools, first aid etc., and may have alternate uses as a lunch or break room, training area, or fresh air base, but their primary function must be as a refuge station. [See Appendix A – Example of Permanent Refuge Station Layout, Page 27.](#)

**Portable Refuge Stations** — Portable refuge stations are airtight, prefabricated fire resistant units in which workers can gain refuge from a contaminated atmosphere. Note that for a portable refuge station to be considered fire resistant, it must include an insulating product other than steel, which would not provide sufficient protection from an extended fire.

Portable refuge stations should be placed in competent ground, and on a stable base to ensure they will remain stationary. The contents and features are the same as in a permanent refuge station, and a portable station can be considered to be “permanent” in status, but logistically they are moveable.

Portable refuge stations come in various sizes but are usually smaller than permanent stations, and do not offer the same flexibility of use as a lunch room or training area. They are, however, comparatively quick and easy to establish, and can be moved when no longer required in a specific location.

All manufacturer recommendations and specifications should be considered mandatory.

**Emergency/Temporary Safe Areas** — This term may apply to portable temporary life-saving measures including manufactured and commercially available products such as fresh air tents, emergency fresh air stations, and dropdown tents, as well as improvised shelters and barricaded areas, where workers can stay safe until rescued or released from the state of emergency. Devices designed for temporary shelter are essentially large respirators and to comply with Regulation 854: Mines and Mining Plants Section 265, the breathable air should meet CSA Z180.1-00, “Compressed Breathing Air and Systems”.

They should not be considered a refuge station, but can be a component of emergency response and a shelter of last resort. Though they lack comfort features, fail to meet minimum legislated standards for a refuge station, and are generally capable of preserving life for only a limited time, emergency/temporary safe areas can play a lifesaving role during emergencies.

### **Entrance**

Entry should be through a double entry door system with an airlock. The airlock serves to permit an easy and safe transition from a contaminated atmosphere to a clean atmosphere. The doors and door frames should be steel, open and close properly, and be latched. Doors must seal airtight, and should a pressure leak occur, clay or other sealant must be readily available to restore the airtight seal between the refuge station and the outside environment. Refuge stations must be capable of maintaining both positive pressure and holding a vacuum. Doors and the airlock should be of a size to allow easy access. Additional considerations for the size and volume of the airlock should include the number of entries that may occur during an emergency and the use of an air purge system for the airlock.<sup>1</sup>

Pressure within the airlock should not exceed a maximum 500 Pa. Doors should be equipped with a small vent, capable of being sealed and opened by hand, to release air pressure and exhaust stale air from the refuge station. A porthole-type window adjacent to the door can enable people inside the station to see someone attempting to enter, and allow them to assist if necessary. It also permits mine rescuers to visually check the occupants, and possibly assist in communication.

A telephone located outside the refuge station, or outside and inside the airlock would enhance the ability of mine rescue teams to communicate with occupants of the refuge station and with the surface.

1 – For additional information: **Investigation of Purging and Airlock Contamination of Mobile Refuge Alternatives**, National Institute for Occupational Safety and Health (NIOSH), 2014 ([www.cdc.gov/niosh/mining/UserFiles/works/pdfs/2014-116.pdf](http://www.cdc.gov/niosh/mining/UserFiles/works/pdfs/2014-116.pdf)); **Facilitating the Use of Built-in-place Refuge Alternatives in Mines**, National Institute for Occupational Safety and Health (NIOSH), 2015 ([www.cdc.gov/niosh/mining/UserFiles/works/pdfs/2015-114.pdf](http://www.cdc.gov/niosh/mining/UserFiles/works/pdfs/2015-114.pdf)).

## Capacity

The capacity of a refuge station should be based on the expected maximum number of individuals to be working within the area. Further consideration should be given to additional numbers that may frequent the location at various times (e.g. geologists, visitors, inspectors, trainees, mine management, etc.).

To accommodate the potential for such people in the vicinity from time to time, the station should have a capacity of at least double the number of locally operating workers, or a system (e.g. shift plan, entrapment tag board) should be implemented to limit personnel in the area. There must be adequate seating for all occupants.

At no time should the refuge station be posted to limit the number of people within. For example, if people are touring the level when an emergency occurs, they are not to be turned away because of initial design considerations.

## Duration

The duration for which a refuge station could be in use should be based on the likely time required to affect a rescue or mine recovery. Portable refuge stations are rated for duration, but a minimum of 24 standalone hours (i.e. without external services such as water and/or compressed air, which can be compromised in a mine fire or emergency) is recommended in designing a permanent refuge station.

## Signage

Fluorescent directional signs should be posted in drifts, ramps, roadways and other locations throughout the mine, pointing to the nearest refuge station. Additional fluorescent signage should be placed on the refuge station. The station should be easily recognizable from the outside during times of poor visibility. A high intensity flashing light or beacon, and/or an audible alarm, may be fitted by the entrance. The location of all refuge stations must be indicated on mine plans.

## Respirable Atmosphere

Providing a source of safe respirable air, independent of the mine environment, during an underground emergency is an essential function of a refuge station. Consequently, measures must be taken to provide an adequate supply of air for the maximum number of occupants in a refuge station for a minimum 24 hours. As well, the atmosphere must also be maintained at a positive pressure at all times to prevent the risk of contamination from outside the station.

The respirable atmosphere may be supplied directly through a dedicated and protected compressed air line from an oil-free source on the surface. The compressor supplying the air should be an oil-free unit, providing fresh air. A three-stage FRL (filter/regulator/lubricator) should be mandatory for any industrial air source. There is a risk, however, that the external air supply may be severed, so an independent means of supply must be provided.

A combination of measures involving dilution and/or recirculation may be required to provide a secure air supply. Oxygen can be replenished by adding normal air as long as a source is available and excess CO<sub>2</sub> and carbon monoxide (CO) can be removed or sufficiently diluted.

Options include:

- Dead air space volume – A minimum room (refuge station) volume can be specified based on the maximum number of occupants. The volume required, approximately one cubic metre per person per hour for 24 hours, will usually make a refuge station based on dead air space alone impractical.
- Compressed air cylinders are not viable for long durations or high numbers of occupants because of the large quantity of cylinders required to protect the atmosphere. Low quantities of compressed air cannot effectively dilute the CO<sub>2</sub> produced by the occupants.
- Medical-grade oxygen in cylinders can replenish the O<sub>2</sub> supply in the air – a minimum flow rate of 0.5 litres per person per minute is recommended – and dilute the level of CO<sub>2</sub>. The carbon dioxide levels, however, must still be controlled despite the introduction of O<sub>2</sub>.
- Oxygen candles may be considered as an alternate backup, but are not generally recommended due to the uncontrolled release of heat and oxygen.
- Air recirculation – mechanical air scrubbers can reduce the level of CO<sub>2</sub> in the air, but do not replenish the depleted O<sub>2</sub> supply. Medical-grade O<sub>2</sub> in cylinders can be used to replenish O<sub>2</sub>.

Whichever method(s) is selected, the recommended oxygen (O<sub>2</sub>) level for a refuge station is 21 per cent, while the carbon dioxide (CO<sub>2</sub>) level should be limited to a maximum 0.5 per cent. At 0.5 per cent CO<sub>2</sub> (the Time Weighted Average under Ontario's Occupational Exposure Limits), respiration is stimulated. Respiration will increase exponentially and become labourious with a further rise in CO<sub>2</sub>.

In calculating measures, note that at rest and in a non-stressed state, a 70 kg person will breathe in air at a rate of about 7.5 litres per minute and expire air at 17 per cent O<sub>2</sub> and 3.2 per cent CO<sub>2</sub>. This results in a 'resting' oxygen uptake of 0.3 litres of O<sub>2</sub> per minute and a 'resting' CO<sub>2</sub> discharge of 0.24 litres per minute.

## Atmospheric Monitoring Equipment

As the safety and security of the occupants of a refuge station depends on the air they breathe, it is vital to monitor the quality of that air. Conditions within a refuge station can deteriorate rapidly, so monitoring equipment must be provided for O<sub>2</sub>, CO<sub>2</sub> and CO levels, as well as temperature and the air pressure differential. Air quality should be monitored and recorded on an hourly basis, or at a shorter interval if required. Remote monitoring of atmospheric conditions from the surface would be beneficial.

An acknowledgeable audible alarm – to avoid undue stress and annoyance to occupants – should indicate when CO<sub>2</sub> levels reach predetermined ranges (Alarm 1 Level at 0.5 per cent and Alarm Level 2 at 1 per cent). Alarms should be action points for occupants. Personnel must be trained in the devices provided, as well as the proper procedure to use when an alarm is activated. The devices must be regularly maintained and tested.

## Environmental Control

In addition to maintaining a respirable atmosphere, refuge stations must be designed to maintain tolerable conditions in terms of temperature and humidity. An air conditioner and/or heater should be installed and maintained in working order. Temperature and humidity must be controlled inside the station as they are critical factors in the comfort and survival of personnel using the station. A wall thermometer should be placed inside the refuge station.<sup>1</sup>

Air conditioning units and ventilation fans that supply fresh air to the refuge station under normal operating conditions, must be capable of being disconnected during an emergency, and their intake vents or pipes must be capable of being closed. Wall-mounted units that do not have intakes can be effective in controlling temperature.

## Potable water

There should be sufficient potable water, either bottled or piped, at the refuge station to adequately supply a full complement of occupants for 24 hours. If a piped supply of water is installed, it should be brought from the surface to the station via an independent, dedicated non-metallic pipe. If bottled, at least three litres of water per person – adequate for 24 hours – should be available. The supply should be labelled for “Emergency Use Only” and rotated out at least annually.

1 – For additional information: **Atmospheric Management in Refuge Stations**, Center for Disease Control (CDC) and National Institute for Occupational Safety and Health (NIOSH) ([www.cdc.gov/niosh/docket/archive/pdfs/niosh-125/125-atmospheremanagementf-m.pdf](http://www.cdc.gov/niosh/docket/archive/pdfs/niosh-125/125-atmospheremanagementf-m.pdf)).

## First Aid Supplies

The quantity and level of first aid equipment provided should be commensurate with the capacity of the refuge station, as well as the type of injuries likely to be encountered. A stretcher, backboard and blankets are required. These and other supplies may be shared with a mine rescue team, if necessary.

Since workers arriving at the station may have suffered smoke exposure, an eyewash station and supplies are recommended. Oxygen therapy equipment is also recommended. Personnel should be trained in first aid and the proper use of the equipment.

## Emergency Equipment

A 10-lb. dry chemical fire extinguisher, recommended for external use only, and an adequate supply of emergency tools – axes, saws, ropes, shovels, jacks, etc., must be available. The tools should be located within or in close proximity to the refuge station. The fire extinguisher should be located adjacent to the door, and the fire load in the station should be kept to a minimum.

## Procedures and Plans

**Emergency procedures and refuge station procedures** must be posted inside the station, preferably on a bulletin board and visible to all occupants. **Ventilation and level plans** should be posted inside the refuge station showing station location, possible escape routes, fresh airways, and ventilation flows. Posted plans and procedures must be kept current.

## Secure Electrical Service

While under normal circumstances power can be supplied from the mine electrical system, this may not be the case during an emergency. Refuge stations must be provided with a backup system to provide power to lighting, heating and cooling, electronic control systems and other services. If batteries are used, they should be located outside the station to minimize the risk of fire, explosion or exposure to fumes. External batteries and wiring should be protected by using fire-proof containers and insulation. When mine temperatures are not maintained between 20 to 30 degrees Celsius, temperature compensation to ensure battery capacity is required. The backup system should be capable of providing adequate electricity to the station for at least 24 hours.

## Lighting

Sufficient and suitable lighting must be installed and in working order. A bright daylight-equivalent environment can help reduce the psychological stress of confinement in a refuge station.

## **Communications**

A refuge station must have a means of voice communication (i.e. radio, telephone) with the surface. Regular communications with the surface can help reduce the psychological stress experienced by station occupants. A system that allows communication through the wall of the station to the outside should also be installed. A backup communication system should be considered. A list of emergency contacts must be readily available and posted at each device.

## **Toilet**

Private toilet facilities are necessary but need not be overly sophisticated. A self-contained portable unit of adequate capacity is sufficient, bearing in mind the capacity of the refuge station and an occupancy of up to 24 hours. Toilet paper and personal hygiene items – towels, soap, etc., should be provided. Where feasible, consider locating the toilet in a separate airlock compartment for purposes of privacy and odour control.

## **Food Supply**

In the context of an emergency in an underground mine, starvation is unlikely to be an issue. Though the human body is ill-equipped to cope with dehydration, people can survive for long periods without food. However, the provision of food may assist with maintaining mental well-being. Nutritional emergency ration packs of dry or dehydrated food can be provided. Sufficient consumables should be available to support the maximum number of occupants for 24 hours.

## **Other Supplies**

Housekeeping items, such as a garbage can and bags, towels, soap, cups, as well as small appliances, such as a fridge, microwave, toaster oven, should be considered if space permits. Care should be taken to ensure any increase in the fire risk is minimal.

Consideration should also be given to measures that improve comfort, such as adding backrests to benches or providing cushioned seating. Reduced physical stress helps to ease psychological discomfort.

Means of distraction, such as books, playing cards, dominoes, and simple games should be provided. This not only provides light relief but has also reduces stress levels. Distractions that require physical exertion should be avoided due to space limitations, and because they increase individual oxygen demand and physical heat output.

## **Commissioning, Inspection and Maintenance**

### **Commissioning and Relocation Tests**

A commissioning test should be conducted whenever a permanent refuge station is established or a portable refuge station is installed for the first time underground, and each time a portable refuge station is moved to a new location. This should include:

- A differential atmospheric pressure test to ensure the integrity of the refuge station, including seals and regulators
- A positive pressure test to ensure the operation of vents
- Testing the electrical power support in all operational states
  - Mains in standby and recharge capability
  - Independent supply in changeover to standalone condition and in change back to standby or recharge
- Testing the station air to ensure that it is free of water and hydrocarbon contamination
- Testing other critical systems (e.g. climate control system, oxygen regulator, gas monitors) to ensure they are operational.

### **Inspection and Maintenance**

For a refuge station to fulfil its purpose in a mine, it should be ready at all times for immediate, dependable use, even if it serves a secondary purpose. Housekeeping should be ongoing to ensure a clean facility. Maintaining the integrity of the refuge station requires an effective and rigorous inspection and maintenance regime.

Based on an assessment of factors such as usage, location, proximity to vehicular traffic, and percussion from blasting, stations should be inspected regularly, and basic tests conducted to ensure full functionality. Portable refuge stations that have been moved should be inspected after each relocation and on a regular basis following the relocation.

An inspection checklist and procedures for the maintenance of each refuge station must be developed outlining the people responsible and the frequency of inspection. See [Appendix B – Example Inspection Checklist, Page 29](#). It is recommended inspections be done at least monthly. In the case of a portable refuge station, the checklist and maintenance must be based on the manufacturer instructions.

Ideally, daily inspections are conducted by workers with a vested interest in the proper functioning of the station — in other words, people who may have to rely on the station for their personal safety or the safety of those they supervise.

Similarly comprehensive inspections must be developed and regularly conducted on emergency/temporary safe areas, such as fresh air tents.

All inspections should be recorded and a copy retained within the station. Another copy should be directed to the department responsible for the re-supply and maintenance of the station, such as the safety department. This has the advantage of creating an auditable record for scrutiny by management.

Any deficiencies should be reported at once to the Underground Supervisor, Underground Manager or to the safety department on site, who should arrange for the problem to be dealt with immediately.

Where a deficiency cannot be remedied quickly, underground crews should be informed of the non-availability of the station, and advised of the alternative arrangements in the event of an emergency.

Responsibility for the ongoing integrity of a mine's refuge station or stations should be clearly established by mine management. Any repair or maintenance work must be undertaken by competent persons who are trained and have access to the necessary information and equipment to undertake their duties.

Irrespective of the arrangements for maintenance and repair, the employer has a duty of care to ensure that sufficient refuge stations are available and fully functional for use as safe havens by the underground workforce at all times.

## **Training**

Personnel using refuge stations during an emergency could experience high levels of stress and anxiety. Therefore, it is important for their safety that they are properly instructed and trained in the station's correct operation, and that they have regular opportunities for hands-on practice of their skills.

Basic training on the use of refuge stations should be included during worker orientation, and include a site visit to a refuge station for hands-on training. A refuge station could be set up on the surface for training. Orientation training should also occur whenever a new station is commissioned or whenever a portable refuge station has been relocated.

Training should include:

- Types of stations used on site
- Emergency procedures that lead to the use of the refuge station
- Refuge station procedures
- Identification and location of key refuge station resources (emergency procedures, first aid kit, toilet, emergency box, communications system, etc. . .)
- Inspection/maintenance procedures for the refuge station between emergencies
- The importance of not tampering with emergency equipment and supplies
- Procedures for the maintenance of the refuge station following use for other purposes, if applicable.

Specific demonstration and hands-on training should be given in any special procedures, and the use of any refuge station equipment, including:

- Use of the communications system(s)
- Activation of oxygen system(s) (cylinders, oxygen regeneration, etc. . .)
- Atmospheric monitoring equipment.

In operations, where portable refuge stations are used, training must follow all manufacturer recommendations. Site trainers should be trained and assessed as competent by the manufacturer.

The effectiveness of training can be increased by using case studies or examples from mining workplaces to demonstrate risk management principles for specific hazards.

There must also be a system to ensure personnel are retrained and reassessed in person on a regular basis, at least annually, as well as whenever systems or equipment change. Maintenance training must include hands-on activities. Opportunities exist during mock emergencies and required fire drills to retrain personnel on the policies and use of refuge stations. The use of refuge stations in these exercises will also help to identify possible inadequacies. A review of

their use should be a part of the post-exercise assessment, and any changes to procedures identified as necessary by the review should be put into practice.

Records of training, training exercises involving a refuge station, and reviews of those exercises should be kept.

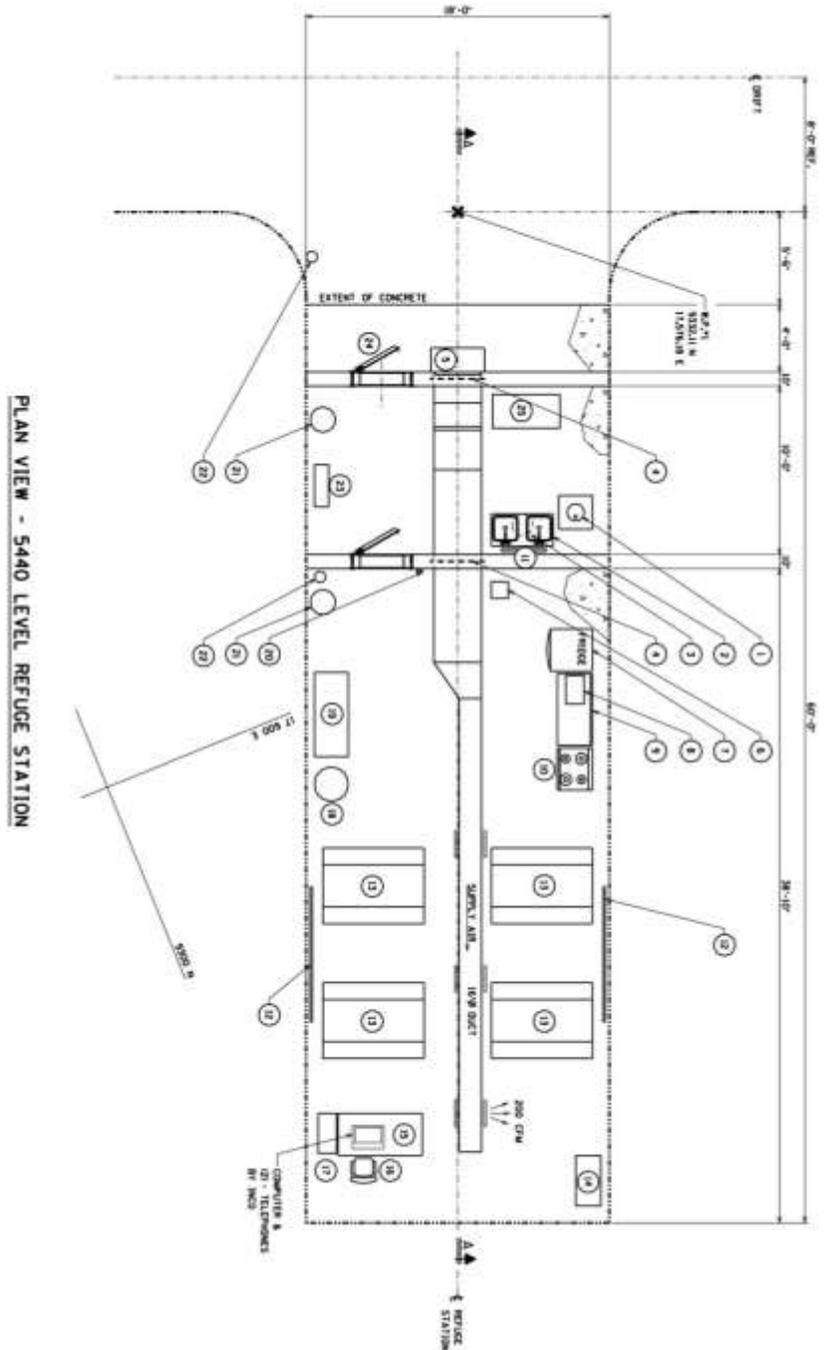
Specific training must be provided to personnel in emergency/temporary safe areas, such as fresh air tents, at all operations where they are available for use. Training must be specific to the device used, and include all manufacturer recommendations. These devices should not be substitutes for refuge stations.

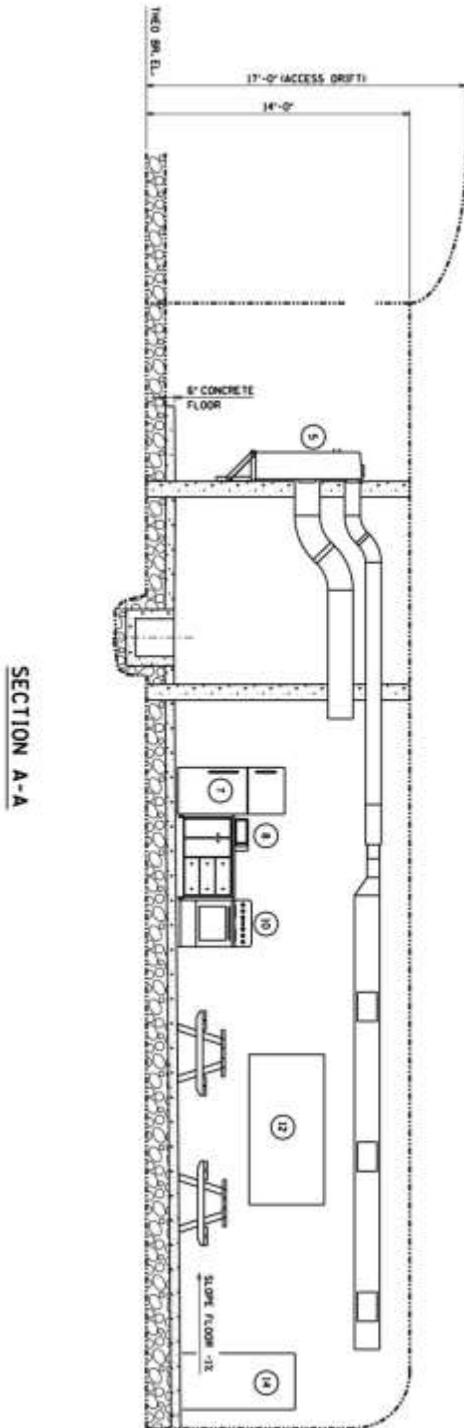
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## Appendix A – Example Permanent Refuge Station Layout

#	Description
1	Sump pump
2	Steel sinks
3	Water heater
4	Smoke damper
5	Air conditioner
6	Eye wash station
7	Refrigerator
8	Microwave oven
9	Table/counter
10	Warming oven
11	Mirror
12	Cork bulletin board
13	Picnic table
14	First Aid/Stretcher
15	Foreman desk
16	Foreman chair
17	Filing cabinet
18	Water cooler
19	Water cooler rack
20	Wall-mounted thermostat
21	Fire clay
22	ABC fire extinguisher
23	Fibre panel
24	Door
25	Supply cabinet
26	Pressure reducing valve
27	Door





**PLAN VIEW - 5440 LEVEL REFUGE STATION**

## Appendix B – Example Inspection Checklist

Item	Status	Comment
Ground Conditions		
Station Doors/Latches (condition, working properly)		
Fire clay/sealant		
Structure (ceiling, walls, floor including drainage)		
Electrical Installations (condition, standard, usage)		
Lighting		
Heating/Cooling		
Seating/Size		
Housekeeping (clean, garbage can with lid)		
Appliances (fridge, microwave, etc... clean and functioning)		
Washing/disinfecting facilities (hot water, soap, disinfectant, towels)		
Toilets (clean, functioning, supplied)		
Potable Water Supply (adequate, functioning, pressure)		
Cups available		
Emergency food supply (adequate, current date)		
Air supply (cylinders, functioning, pressure)		
Ventilation		
Bulletin Board		
<ul style="list-style-type: none"> <li>• Fire Procedures</li> </ul>		
<ul style="list-style-type: none"> <li>• Emergency Procedures</li> </ul>		
<ul style="list-style-type: none"> <li>• Refuge Station Procedures</li> </ul>		
<ul style="list-style-type: none"> <li>• Ventilation Plans (current)</li> </ul>		
<ul style="list-style-type: none"> <li>• Injury Report Info</li> </ul>		
<ul style="list-style-type: none"> <li>• Emergency Contacts (current, accurate)</li> </ul>		
Telephone		
Fire Extinguisher		
First Aid kit		



## **Appendix C – Additional Resources**

**Atmospheric Management in Refuge Stations**, Center for Disease Control (CDC) and National Institute for Occupational Safety and Health (NIOSH)

([www.cdc.gov/niosh/docket/archive/pdfs/niosh-125/125-atmospheremanagementf-m.pdf](http://www.cdc.gov/niosh/docket/archive/pdfs/niosh-125/125-atmospheremanagementf-m.pdf)).

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D.J. Brake, Fellow and G.P. Bates, The AusIMM Proceedings No. 2, 1999 ([aqualyte.com.au/wp-content/uploads/2015/01/Criteria-for-the-design-of-emergency-refuge-stations-for-an-underground-metal-mine.pdf](http://aqualyte.com.au/wp-content/uploads/2015/01/Criteria-for-the-design-of-emergency-refuge-stations-for-an-underground-metal-mine.pdf)).

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([www.cdc.gov/niosh/docket/archive/pdfs/NIOSH-125/125-ExplosionsandRefugeChambers.pdf](http://www.cdc.gov/niosh/docket/archive/pdfs/NIOSH-125/125-ExplosionsandRefugeChambers.pdf)).

**Facilitating the Use of Built-in-place Refuge Alternatives in Mines**, National Institute for Occupational Safety and Health (NIOSH), 2015

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([www.hse.gov.uk/pubns/mines08.pdf](http://www.hse.gov.uk/pubns/mines08.pdf)).

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**Investigation of Purging and Airlock Contamination of Mobile Refuge Alternatives**,

National Institute for Occupational Safety and Health (NIOSH), 2014

([www.cdc.gov/niosh/mining/UserFiles/works/pdfs/2014-116.pdf](http://www.cdc.gov/niosh/mining/UserFiles/works/pdfs/2014-116.pdf)).

**Portable Refuge Chambers: Aid or Tomb in Underground Escape Strategies**, J.M. Venter et al, Journal of the Mine Ventilation Society of South Africa, January/March 1999.

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([www.infomine.com/library/publications/docs/RefugeChambers2005.pdf](http://www.infomine.com/library/publications/docs/RefugeChambers2005.pdf)).

**Refuge Chambers in Underground Mines**, Government of Western Australia, Department of Mines and Petroleum Resources Safety, 2013

([www.dmp.wa.gov.au/Documents/Safety/MSH\\_G\\_RefugeChambersUGmines.pdf](http://www.dmp.wa.gov.au/Documents/Safety/MSH_G_RefugeChambersUGmines.pdf)).

**Underground Refuge Stations in Mines**, Health and Safety Guideline, Ontario Ministry of Labour, 2015 ([www.labour.gov.on.ca/english/hs/pubs/gl\\_refuge.php](http://www.labour.gov.on.ca/english/hs/pubs/gl_refuge.php)).