The United States Department of Labor

Mine Safety and Health Administration

REFUGE ALTERNATIVES – The Last Line of Defense

Penn State Miner Training Program

Technology Transfer Seminar

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While we will be discussing refuge alternatives today, we need to remember:

Escape is always the first option.

Always try to evacuate prior to seeking refuge.

BACKGROUND

The explosions at the Sago Mine on January 2, 2006, and the Darby Mine No. 1 on May 20, 2006 were especially relevant to some provisions contained in the final rule.

The MINER Act

The Mine Improvement and New Response Act (MINER Act) was signed into law on June 15, 2006.

This legislation contained provisions to improve safety, health, preparedness, and emergency response in U.S. mines.

The MINER Act required mine operators to develop and maintain a preparedness and response plan (Emergency Response Plan) to reduce delays and improve quality of response.

The MINER Act

Section 13 of the MINER Act of 2006 required NIOSH to conduct "research, including field tests, concerning the utility, practicality, survivability, and cost of various refuge alternatives in an underground coal mine environment, including commercially available portable refuge chambers."

NIOSH was required to submit the report on their research to the Secretary of Labor and other government agencies no later than 18 months after the date of enactment of the MINER Act.

NIOSH Report on Refuge Alternatives, 2007

The report concluded that refuge alternatives have the potential for saving the lives of mine workers if they are part of a comprehensive escape and rescue plan, and if appropriate training is provided. Two types of viable refuge alternatives had emerged: in place shelters and portable chambers that are inflatable or rigid. Portable chambers are well-suited to providing a refuge alternative to workers as the active face advances or retreats.

NIOSH Report on Refuge Alternatives, 2007

MSHA's final rule
implemented section 13 of the Mine Improvement and New Emergency Response (MINER) Act of 2006.
Consistent with the MINER Act, it included MSHA's response to the NIOSH Report on
Refuge Alternatives.

NIOSH Recommendations from Report of December 2007

PARAMETER	RECOMMENDED VALUE OR PRACTICE
Minimum Rated Duration	48 hours
Strength	15 psi overpressure for 0.2 seconds
Anchor System	Not recommended at this time
Fire Resistance	300° F for 3 seconds
Deployment Time	Minimize this time when establishing the location of the refuge alternative and consider as part of travel time
Minimum Oxygen Concentration	18.5%
Maximum Oxygen Concentration	23%
Maximum Carbon Monoxide Concentration	25 ppm
Gases to be Monitored Inside Chamber	Oxygen, Carbon Monoxide, Carbon Dioxide
External Gases to be Monitored	Oxygen. Carbon Monoxide
Maximum Carbon Dioxide Concentration	1.0%, not to exceed 2.5% for any 24-hour period
Apparent Temperature	95° F
Entry and Exit	Provide a means of egress without contamination the internal environment and/or a means to maintain a safe environment during and after ingress/egress
Potable Water per Person	2 to 2.25 quarts per 24 hours
Durability	Structurally reinforced and of sufficient physical integrity to withstand routine handling
Purge Air Volume	No specific recommendation (see Entry and Exit parameter)
Food, per Person	2,000 calories per 24 hours
Human Waste Disposal System	Required
First Aid Kit	Required
Occupant-Activated Annunciation	Battery-powered strobe light or radio homing signal
Communication with Surface	Survivable post-disaster system
Minimum Distance to Working Face	1,000 feet
Maximum Distance from Working Face	Distance that a miner could reasonably travel in 30-60 minutes, under the expected travel conditions
Security	Visual indication that a refuge alternative has been entered; inspection and maintenance actions required subsequent to discovery
Repair Materials	Materials and instructions supplied by manufacturer
Testing and Approval	Required
Unrestricted Floor Space	> 15 ft^2 per person
Unrestricted Volume	> 85 ft^3 per person
Capacity	Sufficient to accommodate the maximum number of miners in the area to be served by the refuge alternative

Final Rule

Refuge Alternatives for Underground Coal Mines

December 31, 2008

Final Rule: Refuge Alternatives for Underground Coal Mines – December 31, 2008

Requires operators of underground coal mines to provide refuge alternatives to protect miners when a life-threatening event occurs that makes escape impossible.

Final Rule: Refuge Alternatives for Underground Coal Mines – December 31, 2008

The Final Rule was based on:

- Agency data and experience
- Recommendations from the NIOSH report on refuge alternatives
- Research on available and developing technology
- Public comments and hearing testimony

Final Rule: Refuge Alternatives for Underground Coal Mines – December 31, 2008

The Final Rule included requirements for:

- Part 7 required testing and approval of refuge alternatives and components of refuge alternatives
- Assuring that refuge alternatives are readily available, capable of sustaining trapped miners for **96 hours**, and maintained in operating condition
- Training miners to locate, use, maintain, and transport refuge alternatives

Final Rule: Refuge Alternatives for Underground Coal Mines – December 31, 2008

PART 7

- Applies to manufacturers of refuge alternatives and components.
- Includes testing by manufacturer or third party and MSHA approval requirements of pre-fabricated, self-contained refuge alternatives and components.

Final Rule: Refuge Alternatives for Underground Coal Mines – December 31, 2008

PART 75

- Applies to coal mine operators.
- Contains safety standards for refuge alternatives including:
  - ✓Minimum capacities and requirements
  - ✓Locations
  - ✓Maintenance
  - ✓Training requirements
  - ✓Emergency response plan requirements

MSHA ERP & R/A Approval Timeline

- **Pre-positioned material type R/A's are permitted until 12/31/2010.**

- **Components (breathable air, air monitoring, and harmful gas removal) of either a prefabricated self-contained unit OR a unit consisting of 15 psi stoppings constructed prior to an event that States have approved and those that MSHA has accepted in ERPs are permitted until 12/31/2013, or until replaced, whichever comes first.**

- **Refuge Alternative Structures (steel boxes) not MSHA Part 7 approved but permitted by Emergency Response Plans (ERPs) cannot be used after 12/31/2018.**

Escape

or

Seek Shelter?

Escape or Seek Shelter?

When a miner's life is threatened during a mine emergency, the miner must immediately get to a place where the threat is non-existent or minimal.

In almost all cases, that place is on the surface. Reaching the surface of the mine then must be the immediate action.

Evacuation or escaping from the mine should be a higher priority over any other action, including seeking refuge.

MSHA Initiative

"Are You Prepared?"
Mine Emergency Preparedness and Response Initiative

- MSHA PowerPoint - Are You Prepared?
- MSHA Mine Emergency Operations
- Demonstration of the beta test version of the MEO Mapping Tool
- Comments on Prevention of Major-Hazard Events Public Meeting on Mine Emergency Preparedness and Response
- Research for Improved Escape and Rescue from Underground Coal Mines
- Mine Emergency Preparedness and Response

Refuge Alternatives

Refuge Alternatives

Two basic types of refuge alternatives permitted:

- Pre-fabricated self-contained units
- Units consisting of 15 psi stoppings constructed prior to an event in a secure space with an isolated atmosphere

Other refuges approved in Emergency Response Plans prior to the implementation of the Final Rule would be phased out over time.

Refuge Alternatives

There are four "components" in all approved refuge alternatives. They are:

- The Structural Component
- The Breathable Air Component
- The Air Monitoring Component
- The Harmful Gas Removal Component

Structural Component

The Structural Component creates an isolated atmosphere and contains and protects the other integrated components and provisions.

A pre-fabricated self contained unit usually consists of a metal box. It may also act as the occupied area or may contain a fabric tent used for occupancy when the unit is activated.

The 15 psi stoppings used for a refuge alternative constructed prior to an event are the structural component and are approved by the District Manager in the Emergency Response Plan.

§ 7.505 Structural components.

The structure shall—

- (3) Include an airlock that creates a barrier and isolates the interior space from the mine atmosphere, except for a refuge alternative capable of maintaining adequate positive pressure.
- (i) The airlock shall be designed for multiple uses to accommodate the structure's maximum occupancy.
- (ii) The airlock shall be configured to accommodate a stretcher without
- compromising its function.
- (4) Be designed and made to withstand 15 pounds per square inch (psi) overpressure for 0.2 seconds prior to deployment.
- (5) Be designed and made to withstand exposure to a flash fire of 300
- °F for 3 seconds prior to deployment.
- (6) Be made with materials that do not have a potential to ignite or are MSHA approved.
- (7) Be made from reinforced material that has sufficient durability to withstand routine handling and resist puncture and tearing during deployment and use.
- (8) Be guarded or reinforced to prevent damage to the structure that would hinder deployment, entry, or use.
- (9) Permit measurement of outside gas concentrations without exiting the
- structure or allowing entry of the outside atmosphere.

Structural Component

Breathable Air Component

The Breathable Air Component is uncontaminated air from oxygen or compressed air cylinders, compressed air lines, or boreholes with fans or compressors.

There are specified flow rates for oxygen/air which must be provided to assure adequate breathable air is available for all miners in the unit for 96 hours.

Air Monitoring Component

The Air Monitoring Component will provide miners the devices to measure carbon monoxide, carbon dioxide, oxygen, and methane inside and outside of the structure from within the structure.

The ability to monitor these gases inside the refuge alternative is critical to the survival of persons occupying the structure for 96 hours.

The ability to monitor the outside atmosphere helps miners inside the unit make crucial decisions regarding rescue and evacuation.

Harmful Gas Removal Component

The Harmful Gas Removal Component is necessary to remove gases such as carbon dioxide from exhaled breath, carbon monoxide from a fire or explosion, and methane.

The harmful gases are removed by chemical scrubbing materials, purge air, or other procedures.

The atmosphere inside the refuge alternative must not exceed 1% methane, 25 parts per million carbon monoxide and average 1% or less carbon dioxide (with excursions not to exceed 2.5 %). The oxygen concentration must be maintained at levels between 18.5% and 23%.

Harmful Gas Removal Component

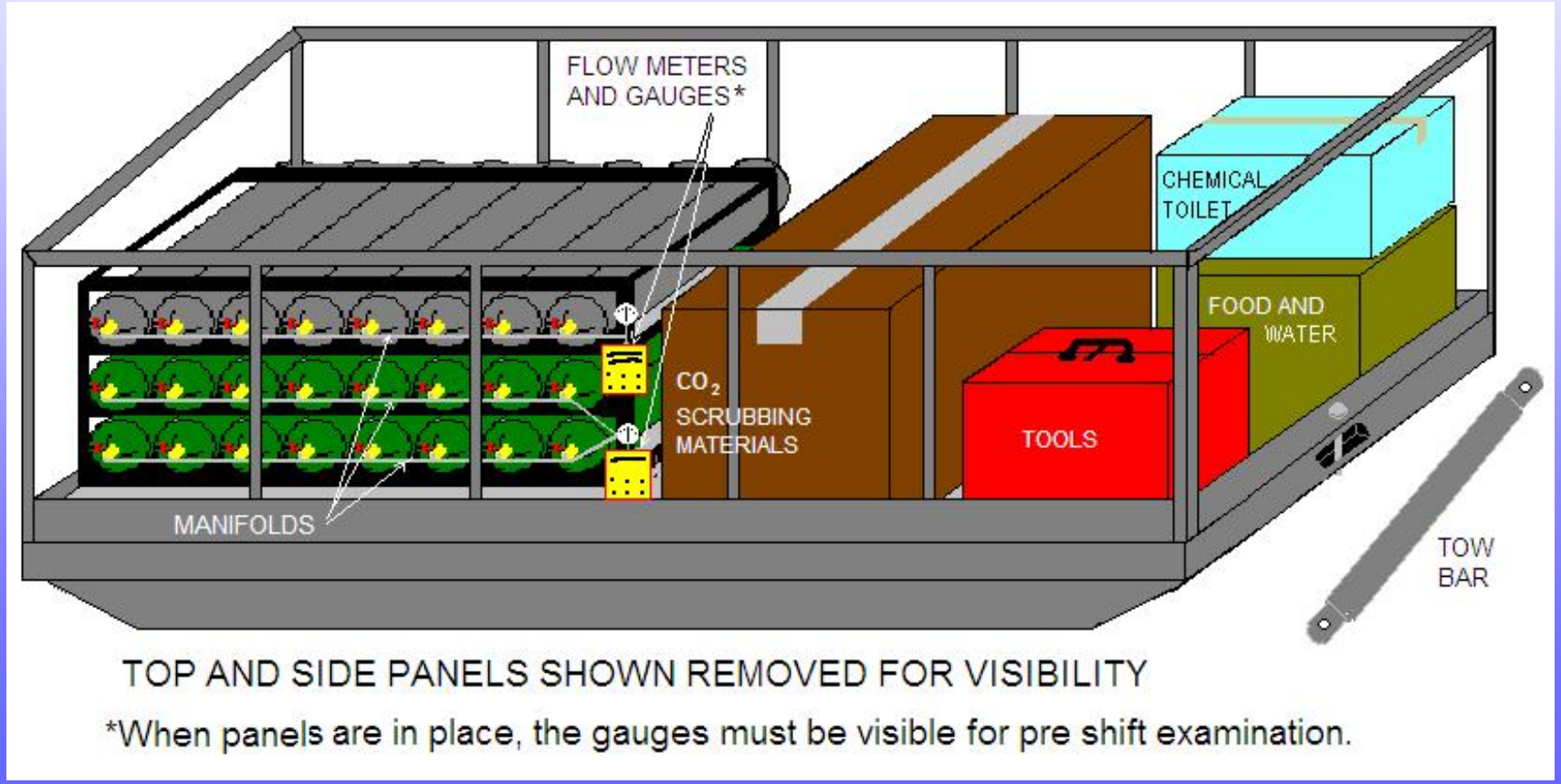
(a) Each refuge alternative shall include means for removing harmful gases. (1) Purging or other effective procedures shall be provided for the airlock to dilute the carbon monoxide concentration to 25 ppm or less and the methane concentration to 1.0 percent or less as persons enter, within 20 minutes of persons deploying the refuge alternative.

Other Provisions Required

The refuge alternative must be supplied with enough food, water, lighting, first-aid supplies, and sanitation facilities to sustain the maximum number of miners expected to occupy the unit for 96 hours.

A two-way communication system that is part of the mine communication system and which can be used from inside the refuge alternative, and an additional communication system and other requirements as defined in the operator's approved Emergency Response Plan are required.

Typical Component and Provision Skid Set-up Placed Behind 15 psi Stoppings



TOP AND SIDE PANELS SHOWN REMOVED FOR VISIBILITY

*When panels are in place, the gauges must be visible for pre shift examination.

Oxygen Safety in Refuge Alternatives

Oxygen Safety in Refuge Alternatives

A dangerous condition can occur if the compressed oxygen system is damaged during movement of the refuge alternative.

Sudden jerks, impacts, or improper handling may result in a leak in the compressed oxygen system.

A slow leak can occur that results in accumulations of oxygen.

Oxygen Safety in Refuge Alternatives

During the stress of a mine emergency, an improperly adjusted oxygen flow rate or unintentional damage to the system by miners can result in an oxygen enriched atmosphere inside of the refuge alternative.

An oxygen enriched atmosphere increases the chances of spontaneous ignitions of materials, such as rags, miners' clothing, papers, or cardboard boxes, containing coal dust, oil, or grease

Oxygen Safety in Refuge Alternatives

Best Practices

- Train all miners in the proper deployment and operation of the breathable air system during a stressful situation.
- Train all miners on the dangers of an oxygen enriched atmosphere and how to determine if a dangerous condition exists in the refuge alternative during deployment, and
- Train miners on methods of eliminating oxygen enriched atmospheres including adjusting flow rates, replacing plumbing components, or purging the unit.

Oxygen Safety in Refuge Alternatives

Best Practices

- Use persons trained in the proper procedures to move the refuge alternatives.
- After the move is completed, make a thorough examination of the atmosphere inside access panels and near the refuge alternative for accumulations of oxygen that would indicate a leak in the compressed oxygen system.

Oxygen Safety in Refuge Alternatives

Best Practices

- If an oxygen leak is discovered, shut off the source of the leak and ventilate the area to remove the oxygen enriched atmosphere. Report any damage that occurred during the move.
- Conduct proper preshift examinations of the refuge alternative, as per the manufacturer's recommendation, to determine the condition of the compressed oxygen cylinders and plumbing.

Oxygen Safety in Refuge Alternatives

- In Nov. 2009 MSHA developed a Safety Hazard Alert titled, "Oxygen Safety In Refuge Alternatives, " which was provided to all refuge alternative manufacturers. It is posted on the MSHA website under Alerts / Hazards section.

- Copies are available here.

Oxygen Safety in Refuge Alternatives

- MSHA also developed "Hazard Awareness: Using Compressed Air and Compressed Oxygen to Provide Breathable Air Underground."
  - This was supplied to all refuge alternative manufacturers and others.

Oxygen Safety in Refuge Alternatives

- Nov. 2009 – Reminder sent to all RA manufacturers concerning hazard analysis that must be conducted.
- Included reference materials:
  - NASA Technical Memorandum 104823, "Guide for Oxygen Hazard Analyses on Components and Systems."
  - NASA / TM-2007-213740, "Guide for Oxygen Compatibility Assessments on Oxygen Components and Systems."

Oxygen Safety in Refuge Alternatives

The risk of accidental ignition is present with all oxygen systems!

Refuge Alternative Training

Refuge Alternative Training

A Refuge Alternative will protect miners in the event of a mine emergency only if they are trained to properly deploy and use the units.

Miners are required to receive expectations training as part of their annual retraining and refresher training on a quarterly basis.

Mine emergencies can result in disorientation and panic.

Using sound judgment in any emergency can be critical for survival.

Refuge Alternative Training

ANNUAL TRAINING

Expectations training helps ensure that underground coal miners know when to use a refuge alternative and know how to deploy and use the various components to sustain life until rescued. Annual expectations training must include:

- Donning and transferring SCSRs in smoke, simulated smoke or an equivalent environment; and
- Breathing through a realistic SCSR training unit that provides the sensation of SCSR breathing resistance and heat.

Refuge Alternative Training

ANNUAL TRAINING

The expectations training also requires an annual realistic experience of deploying and using a refuge alternative found at their mine in a simulated emergency situation.

Properly deploying a refuge alternative or component can be a relatively complex procedure that must be done correctly to establish a breathable air environment in a smoke-filled mine.

Refuge Alternative Training

ANNUAL TRAINING

During annual training, miners would:

- Deploy the refuge alternative;
- Purge the atmosphere;
- Turn on the breathable air;
- Maintain a viable atmosphere; and
- Perform periodic monitoring of and adjustments to the gases to assure a breathable atmosphere.

Refuge Alternative Training

QUARTERLY TRAINING

As part of their quarterly training and drills, miners are required to:

- Located the refuge alternatives on the mine and escapeway map;
- Review the procedures for deploying the refuge alternative;
- Review the procedures for constructing 15 psi stoppings if used in the mine;

Refuge Alternative Training

QUARTERLY TRAINING

- Review the step by step procedures for using the refuge alternative in an emergency situation.
- Receive task training in the proper transportation of refuge alternatives and components to minimize damage. This training should include information on all connections necessary for transportation such as tow bars, clevises, and hitches.

Conclusions

To save lives in a mine emergency, miners must know:

When to use refuge alternatives,

Where refuge alternatives are located,

How refuge alternatives can save lives

Why to use refuge alternatives

Remember:

Escape first – Then seek refuge

QUESTIONS?