

**Advanced
Mine Rescue Training**

Exploration

Module 4

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Course Objectives

The mine rescue team members will be able to prepare for and perform underground explorations under rescue and recovery conditions.

The team members will:

- Explain the purpose of mine rescue exploration.
- Describe the purpose and demonstrate how to establish the Fresh Air Base.
- Describe and demonstrate how to advance the Fresh Air Base.
- List and describe the types of equipment needed for mine rescue.
- Explain the purpose of team briefing and debriefing sessions, and list the information that should be included.
- Explore a section of the mine using the two primary methods of exploration.
- Demonstrate proper traveling procedures.
- Use gas testing devices.
- Explain the purpose of progress reporting, identify the items covered in a progress report, and demonstrate the procedure.
- Explain the purpose of mapping, identify the items a team will map, and demonstrate proper mapping.
- If available for training, demonstrate proper set-up and use of real-time communications and electronic mapping equipment.

Course Materials

Required:

- Visuals/handouts from the back of this module
- Pencil and paper for each team member
- Communication System(s)
- Gas testing devices team uses
- IG 7a – Advanced Skills Training Activities for Coal Mine Rescue Teams

Suggested:

- Communication equipment used by MSHA MEO
- Gas testing devices used by MSHA MEO
- Linkline
- Map board
- Laptop and Mapping Software used by MSHA MEO
- Chalkboard/Flipcharts
- PowerPoint program

NOTE: In addition to these materials, you are encouraged to incorporate any other up-to-date supplemental mine rescue instructional materials, handouts, and/or methods that will increase the effectiveness and retention of the training.

Course Outline

- I. Introduction
- II. Examination of Mine Openings
- III. Barefaced Exploration
- IV. The Fresh Air Base
 - a. Establishing a Fresh Air Base
 - b. The Fresh Air Base Coordinator
 - c. Advancing the Fresh Air Base
- V. Apparatus Teams
 - a. Team's Role in Exploration
 - b. Team Equipment
 - c. Equipment Required by Law
 - d. Other Equipment
- VI. Team Briefing Sessions
- VII. Preparing for Exploration
 - a. Team Captain's Responsibilities
 - b. Donning the Apparatus and Getting Under Oxygen
- VIII. Exploration Methods and Procedures
 - a. Rapid Exploration
 - i. Encountering Irrespirable Atmosphere
 - ii. Encountering Smoke
 - b. Advance, Tie Across and Behind
 - i. Advancing and Tying In
 - c. Standard Exploration Procedures and Practices
 - i. Team Checks
 - ii. Rate of Travel
 - iii. Traveling in Smoke
 - iv. Traveling Through Ventilation Controls
 - v. Traveling Through Water
 - vi. Crawling or Climbing
 - vii. Marking Route of Travel
 - viii. Marking Areas Explored
 - ix. Inspecting and Testing Roof and Rib
 - x. Visual Inspections
 - xi. Roof and Rib Tests

- xii. Testing for Gases
- xiii. Progress Reporting
- xiv. Mapping
- xv. Communication
 - 1. Communication Systems
 - 2. Communication with the Fresh Air Base and Command Center
 - 3. Using the Lifeline Cable to Communicate (Signaling)
 - 4. Problems with the Use of the Lifeline
- d. Returning to the Fresh Air Base

IX. Debriefing

- X. Improvements in Mine Rescue Technologies
 - a. Wireless Communications and Tracking Technologies
 - b. Computer-Assisted Mapping

Instructional Text

Introduction

"Exploration" is the term we use to describe the process of assessing conditions underground and locating miners (or clues to their whereabouts) during a rescue or recovery operation.

Exploration is a broad topic. We'll be talking about preparations for explorations, team briefings and debriefings, standard procedures for advancing inside the mine, and the equipment you'll be using during exploration.

NOTE: Rescuing survivors and recovering bodies is covered in *Module 6*.

Examination of Mine Openings

Before anyone goes underground, it's important to examine the mine openings to determine the safest route for entering the mine. Tests should be made for the presence of gases, and someone should make ventilation checks. Whenever possible, it's best to enter the mine by way of the safest intake airway.

In a shaft mine, check the cage to make sure it's operating properly. To test an automatic elevator, run it up and down the shaft manually several times.

Tests should also be made for the presence of gases, smoke, or water in the shaft. If a mine has had an explosion, the cage, signaling devices, and headframe may be damaged. You may have to use a mucking bucket or other improvised means to make your descent provided all five team members will fit. However, a cage should be made available as soon as possible.

If the cage is in good shape but the hoisting equipment is damaged, it may be necessary to use a portable crane to raise and lower the cage if it can be done safely.

Barefaced Exploration

Following some explosions or inundations, conditions may make it possible to conduct an initial exploration without self-contained breathing apparatus. This is known as "barefaced" exploration. Often, barefaced exploration is conducted with apparatus on team members, ready to function. This allows the team to quickly put on their facepieces and get under oxygen if conditions make it necessary.

Barefaced exploration should be conducted only when the ventilation system is operating properly and frequent gas tests indicate that there is sufficient oxygen and no buildup of carbon monoxide, methane or other dangerous gases.

A backup crew with apparatus should be stationed outside the area, ready to go in immediately to rescue others if necessary.

Often, barefaced exploration will not involve all members of a mine rescue team. One or two team members may be called on to participate, but the bulk of the crew may be made up of state and Federal officials, and possibly company officials.

The purpose of such exploration is to establish the extent of damage and to quickly progress in good air to the point where the initial Fresh Air Base will be established.

Because they're not burdened by the extra weight of apparatus, a barefaced crew will probably be able to advance and determine current conditions quickly. They may be able to cover moderate to large distances when conditions are good.

During barefaced exploration, the crew uses **radios and/or** the mine's communication system to report their progress and findings to the surface. This lets the backup team know where the barefaced team is located and whether it's necessary to go in after them.

Barefaced exploration should stop at any point where disruptions in ventilation are found, or when gas tests indicate the presence of any carbon monoxide or other noxious gases, elevated readings of explosive gases, elevated methane readings, or oxygen deficiency. A barefaced crew should also stop exploration when they encounter smoke or damage.

A Fresh Air Base is usually established at the point where conditions no longer permit barefaced exploration. Because the area has already been explored, rescue team members and backup personnel are then free to travel to and from the Fresh Air Base without apparatus. Teams equipped with apparatus continue exploration from the Fresh Air Base.

The Fresh Air Base

The Fresh Air Base (FAB) is the base of operations from which rescue and recovery work advances into irrespirable atmospheres. This is where apparatus crews begin their exploration of the affected area.

The Fresh Air Base also functions as a base of communications for the operation linking the team, the Command Center, and all support personnel.

Establishing a Fresh Air Base

Usually, the operation's initial Fresh Air Base will be established somewhere underground, and then advanced as the exploration proceeds. But if underground damage is extensive, it may be necessary to establish the initial Fresh Air Base on the surface.

Whether you put it underground or on the surface, the Fresh Air Base should be located as close as possible to the affected area of the mine, but situated where it's assured a supply of **fresh air**.

When the Fresh Air Base is set up underground, an air lock must be built to isolate the Fresh Air Base from the unexplored area beyond it. The air lock allows the team to enter and exit the unexplored area without contaminating the air at the Fresh Air Base.

NOTE: Refer to the list of requirements for a Fresh Air Base on **Visual 1**.

Here are some specific factors to consider when you select a site for a Fresh Air Base:

- Be sure the Fresh Air Base is located where it's assured positive ventilation and fresh air.
- If the Fresh Air Base is underground, it should be located where it's assured a fresh air travelway to the surface. This travelway will be used to safely move people and supplies to and from the Fresh Air Base. **If possible, there should also be transportation available.**
- The site should be situated where it can be linked to the Command Center by means of a communication system.
- There should also be a communication system to link the team and the Fresh Air Base.

These factors are probably the most important that help determine where to establish a Fresh Air Base, but there are also some other elements to take into consideration. For example, the area should be free of oil and grease. It should also be well rock dusted.

The Fresh Air Base should be large enough to accommodate all the people who will be using it and allow enough space for them to work efficiently. It's also desirable to have a roof that's high enough for everyone to stand under, and a level floor.

It is often recommended that all possible electrical conductors (track, pipe, wires, etc.) be severed so that the affected area beyond the Fresh Air Base is isolated from any possible stray or direct current.

The Fresh Air Base is normally outfitted with supplies and other equipment to be used during the operation. For example, a typical Fresh Air Base will probably be equipped with gas testing devices, equipment for detecting oxygen deficiency, and perhaps firefighting equipment.

There may also be first aid supplies and oxygen therapy equipment at the Fresh Air Base, as well as tools and replacement parts for self-contained breathing apparatus and a map of the affected area.

If possible, the Fresh Air Base should be supplied with benches, canvas, or brattice cloth on which the backup team can set their apparatus or other supplies.

The Fresh Air Base Coordinator

Stationed at the Fresh Air Base, there will be a person who is responsible for establishing and maintaining orderly operations. This is the "Fresh Air Base Coordinator." There will also probably be an advisory committee at the Fresh Air Base to help the Coordinator.

Sometimes, "runners" are stationed at the Fresh Air Base to carry messages from the Fresh Air Base to the Command Center in the event of a communication breakdown. The runners may also be responsible for other tasks, such as taking gas samples to the surface or monitoring the lifeline. **NOTE:** Refer to **Visual 2** as you discuss the Coordinator's responsibilities.

The primary responsibilities of Fresh Air Base Coordinator include the following:

- Maintain communications with the active rescue team(s) and the Command Center.
- Follow the team's progress on the mine map and mark findings on the map as the team reports them.
- Coordinate and oversee the activities of all personnel who are at the Fresh Air Base, including the advisory committee.

These primary responsibilities include a great number of duties that will be delegated to other personnel, but it's still the Fresh Air Base Coordinator's responsibility to make sure these duties they are carried out.

An incoming Fresh Air Base Coordinator who is relieving another Coordinator, must be briefed on all the necessary up-to-date information to ensure that the changeover goes smoothly.

It's also the incoming Fresh Air Base Coordinator's duty to check communications between the Fresh Air Base and the Command Center to make sure the system is operating properly. The Coordinator also usually reports his or her arrival at the Fresh Air Base, and logs the arrival time.

In addition to this, the Coordinator's duties typically include checking the name or number of the team going inby the Fresh Air Base, checking the condition of the backup team, and checking and logging equipment and materials. The Coordinator should also make sure there is a map of the affected area at the Fresh Air Base.

A Fresh Air Base Coordinator is normally responsible for logging the times that all personnel enter and leave the Fresh Air Base, and for logging the time and nature of all telephone calls.

As work progresses, the Fresh Air Base Coordinator monitors communications from the team members working inby, relays and/or confirms instructions from the Command Center to the team(s), and then relays and/or confirms information to the backup team(s).

If a lifeline is used, it's usually the Fresh Air Base Coordinator's responsibility to make sure someone is stationed at the Fresh Air Base to monitor it. The Fresh Air Base Coordinator should also make sure no unauthorized personnel are permitted to go inby the Fresh Air Base.

The Fresh Air Base Coordinator plays a key role in ensuring that the entire operation runs smoothly and efficiently. The Coordinator maintains crucial communication links with the Command Center and the working rescue team(s).

Because the Fresh Air Base Coordinator's job is so important, it is absolutely essential that everyone at the Fresh Air Base respect the Coordinator's authority and do whatever they can do to help out. In order to make the Fresh Air Base Coordinator's job a little easier, it's also essential that **only those people necessary** to the operation are permitted at the Fresh Air Base.

Advancing the Fresh Air Base

The Fresh Air Base is usually advanced closer to the affected area of the mine as soon as the areas inby the base are explored and re-ventilated. This ensures that the apparatus crews will begin their explorations as close as possible to the affected area of the mine. **NOTE:** Refer to **Visual 3**, as you explain to the team how to advance a Fresh Air Base.

To advance the Fresh Air Base, the team will have to build a new air lock at the site of the new Fresh Air Base and put up any additional temporary stoppings in parallel entries that are needed to seal off the area at that point so that fresh air can be advanced.

Also, the team will have to repair any damaged ventilation controls in the area between the old Fresh Air Base and the new one. However, be sure to leave open the last stopping outby the new Fresh Air Base that goes to the return. If the stopping is intact, open it. This ensures that the area can be properly flushed out and ventilated.

Next, return to the old Fresh Air Base and remove or open that air lock and any stoppings in parallel entries. This permits air to enter inby the old Fresh Air Base and flush the area up to the new Fresh Air Base.

Before everyone is moved up to the new Fresh Air Base, the area between the old and the new one should be explored by a mine rescue team or by a crew of company, state and Federal officials. Using gas testing devices, check all dead ends, intersections, and high places in the area to make sure it's adequately ventilated.

Once the entire area is explored, all appropriate checks have been made, and the area is declared safe, the team and other designated personnel can then advance the Fresh Air Base.

NOTE: If gases are found to have accumulated in areas that are difficult to clear by means of regular ventilation (very high or low spots, etc.), it may be necessary to use line brattice to channel the flow of air directly into these areas. The team may do this by holding up the brattice so that it directs air into the places where the gases have collected.

Review questions: Ask the team members the following questions and allow time for them to answer. Discuss the answers with them so they fully understand the material covered in this section.

1. What is a Fresh Air Base?

Answer: The Fresh Air Base is the underground base of operations and starting point for rescue and recovery work into irrespirable atmospheres.

2. What are some of the requirements for a Fresh Air Base?

Answer: The Fresh Air Base must be situated where it's assured of positive ventilation, supply of fresh air, and a travelway to the surface for people and equipment. It must also have communications systems linking it to the Command Center and to the mine rescue team. It is also best if the area is well rock-dusted and free of oil and grease. A level floor and a roof high enough for everyone to stand are also desirable.

3. What are the three main duties of the Fresh Air Base Coordinator?

Answer: The Fresh Air Base Coordinator handles communications with the team and the Command Center, maps the team's progress and findings, and coordinates and oversees the activities of all designated personnel at the Fresh Air Base.

4. How do you advance a Fresh Air Base?

Answer: To advance the Fresh Air Base, construct a new air lock and any stoppings in parallel entries that are needed, repair ventilation controls to the point where the new Fresh Air Base is located, and provide an opening to the return. Then return to the old Fresh Air Base and remove that air lock and any stoppings in parallel entries in order to ventilate the new area. Prior to moving everyone up to the new Fresh Air Base, a mine rescue team or designated crew will need to perform gas tests in all dead ends, intersections, and high places of the newly ventilated area.

Apparatus Teams

Once the Fresh Air Base is established, apparatus teams will be sent inby to explore the affected area. This exploration may require only one or two trips inby, or it may continue through many team rotations. How many trips will be needed to complete the exploration (and how long it will take) will depend on the extent of the area involved and the conditions within the affected area.

Team's Role in Exploration

During exploration, the team travels in potentially hazardous atmospheres. Roof and rib conditions will be uncertain—and perhaps hazardous.

As the team progresses through the mine, team members make gas tests and assess conditions. The team also searches for clues as to where survivors may be located, and locates fires. All these findings are mapped and reported to the Fresh Air Base as the team proceeds.

As you explore, keep in mind that your first priority is team safety. The rescue of survivors comes second. Your third priority is the recovery of the mine. During exploration, teams will work according to a rotation schedule. One team, for example, will be scheduled to work inby.

A second team will be stationed at the Fresh Air Base as the “backup team,” and a third team, known as the “standby team,” will be ready and waiting on the surface. Other teams may be scheduled to rest.

NOTE: While a team is “at rest,” it’s important to allow enough time for their apparatus to be cleaned, tested, and prepared for use (and repaired, if necessary).

Because rescue work is strenuous and demanding, it’s important for team members to be well rested. It’s also recommended that you don’t eat within one hour of the time you’ll be wearing your apparatus, and you shouldn’t drink alcoholic beverages for at least 12 to 18 hours before you get under oxygen.

Lack of sleep, a recent meal, or alcoholic beverages can cause you to be sluggish and impair your judgment and reflexes. It’s also a good idea to **limit** intake of stimulants such as coffee, colas, etc., because these substances increase heart and respiration rates.

Team Equipment

Rescue team members use some of the same basic equipment that any underground miner uses. For example, each member will be outfitted with a hard hat, cap lamp, steel-toe shoes or boots, and a metal ID tag.

For rescue work, you will also wear a metal ring on your mine belt so you can hook onto a lifeline or linkline, and it is common practice for everyone to wear a watch. Of course, each team member will also wear a Self-Contained Breathing Apparatus (SCBA).

Equipment Required by Law

30 CFR Section 49.16 – Equipment and maintenance requirements

(a) Each mine rescue station shall be provided with at least the following equipment. Mine rescue stations serving underground anthracite coal mines, which have no electrical equipment at the face or working section, shall have at least the amount of equipment appropriate for the number of mine rescue team members.

- (1) Twelve self-contained breathing apparatus, each with a minimum of 4 hours capacity (approved by MSHA and NIOSH under 42 CFR part 84, subpart H), and any necessary equipment for testing such breathing apparatus.
- (2) A portable supply of liquid air, liquid oxygen, pressurized oxygen, or oxygen generating chemicals, and carbon dioxide absorbent chemicals, as applicable to the supplied breathing apparatus and sufficient to sustain each team for 8 hours while using the breathing apparatus during rescue operations.
- (3) Two extra, fully-charged oxygen bottles for every six self-contained breathing apparatus.
- (4) One oxygen pump or a cascading system, compatible with the supplied breathing apparatus.
- (5) Twelve permissible cap lamps and a charging rack.
- (6) Four gas detectors appropriate for each type of gas that may be encountered at the mines served. Gas detectors must measure concentrations of methane from 0.0 percent to 100 percent of volume, oxygen from 0.0 percent to at least 20 percent of volume, and carbon monoxide from 0.0 parts per million to at least 9,999 parts per million.
- (7) [Reserved].

(8) One portable mine rescue communication system (approved under part 23 of this title) or a sound-powered communication system.

(i) The wires or cable to the communication system shall be of sufficient tensile strength to be used as a manual communication system.

(ii) These communication systems shall be at least 1,000 feet in length.

(9) Necessary spare parts and tools for repairing the breathing apparatus and communication system.

(b) Mine rescue apparatus and equipment shall be maintained in a manner that will ensure readiness for immediate use.

(1) A person trained in the use and care of breathing apparatus shall inspect and test the apparatus at intervals not exceeding 30 days and shall certify by signature and date that the inspections and tests were done.

(2) When the inspection indicates that a corrective action is necessary, the corrective action shall be made and the person shall record the corrective action taken.

(3) The certification and the record of corrective action shall be maintained at the mine rescue station for a period of 1 year and made available on request to an authorized representative of the Secretary.

Other Equipment

Beyond what is required by law, the other equipment your team will use depends on the situation. For example, if you are rescuing survivors, the team will probably carry a stretcher or stokes basket, and an extra approved breathing apparatus for the rescued person. But if your task is to build ventilation controls, the team will probably carry tools and other construction equipment.

Some of the material you need to build ventilation controls (such as brattice cloth) may already be underground, so you will simply pick up what the team needs as you progress through the mine. This also applies to other team tasks that require the use of materials already inside the mine.

Here are some examples of other equipment typically used during exploration:

- High-Range Multi-Gas Detectors
NOTE: Detectors can be configured with an interface and radio in order to provide real-time gas readings, enabling the Command Center to continuously monitor a specific area for gases, in real-time, as opposed to having a team member remain in that area to monitor and communicate gas readings back to the Fresh Air Base and Command Center.
- Oxygen indicator
- Communications Equipment (Including real-time communications system components)
- Lifeline – This refers to the powered communication/lifeline system used as a backup if the main system fails. The team’s communication line is normally used for this.
- Linkline – This is a line or rope, usually equipped with rings, that is used to hook team members together in smoke.
- Mapboard and marker – The mapboard may be fitted with a plexiglass cover to protect the map from water damage in wet mines.
- Roof testing device
- Walking stick – The captain can use a walking stick to probe water depth or to avoid obstructions in heavy smoke.
- Stokes basket or stretcher and blankets
- First aid kit
- Fire extinguisher
- Tools – May include a hammer, nails, axe, shovel, brattice cloth, and possibly a saw, and a wrench to open water line valves. **NOTE: Use non-sparking tools, nails, spads, etc.)**
- Extra approved breathing apparatus (if missing miners are involved)
- Washers with streamers or flags attached for marking hazardous areas, such as bad roof. Mention these items if your team uses them.
- Carpenter’s apron – The captain may use an apron to carry a notebook, pen, and chalk. Other team members may use one for carrying nails, hand tools, etc.
- Thermal Imaging Camera – A thermal imaging camera enables you to locate “hot spots” that you cannot see with your eyes. It works extremely well, especially in smoke, to quickly locate miners and/or fires.

NOTE: Areas where a thermal imaging camera is used **must be monitored constantly** for the presence of explosive gases.

Team Briefing Sessions

Before your team goes underground, they must attend a briefing session. This usually takes place at the Command Center and is usually conducted by a briefing officer and a briefing committee. The briefing committee is generally composed of company and Federal officials and, where applicable, state and union representatives.

Personnel from the Command Center are responsible for conducting briefing sessions, and they determine who should be included in the sessions. It is suggested that the team captain, map man, and, possibly, the team's trainer be included.

At the briefing, the team needs to be informed about what has happened in the mine and what conditions currently exist. The briefing officer will give the captain the team's assignment. This assignment specifies what areas your team will explore.

The briefing officer will also issue your team an up-to-date mine map and give you a time limit within which you should be able to complete your work and return to the Fresh Air Base.

The exchange of information between the Command Center and the mine rescue teams carrying out the assignments is extremely important to the successful completion of the assignment. However, it must be emphasized that the Command Center makes the final decisions regarding all aspects involved in the operation.

The safety of the team is dependent upon accurate, up-to-date information regarding conditions in the mine. The team should ask questions concerning items about which they are unsure, and they need to express to Command Center personnel **any** concerns they have with their assignments. Be sure you have answers to the following questions:

NOTE: Refer to **Visual 4**

- Is the evacuation complete?
- Are any miners missing, if so, how many, and what are their possible locations?
- What is known about the cause of the disaster?
- Is your team the first one to explore?
- Have State and Federal officials been notified?
- Are guards stationed at all mine entrances?
- Is the ventilation system operating? Is it an intake or exhaust system?
- Are attendants posted at the surface ventilation controls?
- Have air samples been taken? If so, what are the results?
- Will there be a backup team ready at the Fresh Air Base, and reserve teams on the surface?
- What are the team's objectives and what is their time limit?
- What conditions are known to exist underground (roof conditions, water, gas, etc.)?

- Is the mine's communication system operating?
- Is it being monitored?
- What other types of communications equipment will team members be required to use during rescue/recovery operations?
- Have team members been trained on the set-up and operation of real-time communications/tracking systems to be used during mine rescue and recovery work?
- Is power to the affected area on or off?
- Is there battery-powered or diesel equipment or a charging station in the affected area?
- What type of equipment is in the area? Where is it located?
- Where are compressed air and/or water lines located?
- Are they in operation? Are valves known to be open or closed?
- What type of firefighting equipment is located underground? Where is it?
- What tools and supplies are available underground? Where are they?
- In the area to be explored are there storage areas for oil or oxygen, acetylene tanks, or explosives?

NOTE: The team should be aware that battery-powered or diesel equipment may still be running **even though power to the area has been cut off.**

Preparing for Exploration

Team Captain's Responsibilities

Before your team proceeds to the Fresh Air Base, it is the captain's responsibility to make sure the team, its equipment, and its apparatus are ready to go. The captain should:

- Check each team member's physical condition, to make sure he or she is physically fit to wear the apparatus and to perform rescue work.
- Ensure that all apparatus have been tested, checked, and are operating properly.
- Make sure the team has all necessary tools and equipment (including the captain's own supplies, such as notebook, pencil, chalk, etc.).
- Make sure the team members understand the briefing instructions and what their individual jobs will be.
- Check battery levels for radios, gas detectors, communications systems.
- Determine which team member(s) will check radio signal strength and monitor the communication system's connection to Fresh Air Base and the Command Center.
- Ensure that each team member understands the instructions given during the briefing session.

Before the team travels inby the Fresh Air Base, it's the captain's responsibility to make sure the team is prepared. The captain should:

- Make sure the gas-testing equipment, the communication equipment, signaling equipment, and stokes basket or stretcher have been checked by the designated people.
- If not the first team to explore, get up-to-date information from the last team (or from the Fresh Air Base Coordinator) about how far the last team advanced and what they found.
- Make sure your team's map person gets an updated map from the last team's map person or from the Fresh Air Base Coordinator.
- Check battery levels for radios, detectors, and communications systems.
- Synchronize watches with the Fresh Air Base Coordinator.
- Discuss with the Fresh Air Base Coordinator the type of communication system that will be used.

NOTE: To ensure that radio signal strength remains consistent throughout exploration, determine **(IN ADVANCE)** at what intervals and/or locations signal strength will be checked.

Donning the Apparatus and Getting Under Oxygen

Once all preparations and last-minute checks have been made, each team member is ready to put on their apparatus and get under oxygen.

NOTE: At this point, you may want to **review your team's procedure** for getting under oxygen.

Once the team is under oxygen, the captain checks each team member and breathing apparatus. The co-captain performs the same checks on the team captain. When the checks are completed, the captain notifies the Fresh Air Base Coordinator that the team is ready to proceed, and asks permission to set out.

Just before the team begins to travel inby the Fresh Air Base, the team captain should be sure to write down the time of departure. The captain may also have the map person to jot down the time on the map for later reference.

Review questions: Ask the team members the following questions and allow time for them to answer. Then discuss the answers with them so they fully understand the material covered in this section.

1. What equipment is a mine rescue team required to have?

Answer:

In addition to the normal underground mining gear (i.e., hardhat, cap lamp, safety shoes, metal ID, and perhaps a watch), the team members wear breathing apparatus, and the team must have two detecting devices (or multi-gas detector) for each gas they may encounter, two oxygen indicators, and a communication system.

2. What type of information is normally covered in a team briefing and/or what questions should team members ask?

Answers:

- Evacuation report—missing miners and possible locations?
 - What may have caused the disaster?
 - Are they the first team to go underground?
 - Have State and Federal authorities been notified?
 - Is property guarded?
 - What is state of ventilation system (fans) and gas conditions at returns?
 - Is backup team available?
 - What are team's objectives and time limit?
 - What are known conditions?
 - What is status of mine's communication system?
 - Is power in mine on or off?
 - What equipment is in the affected area? Is there diesel, battery-powered, equipment, or a charging station?
 - What is the location and/or condition of air and water lines?
 - What type of firefighting equipment is underground and where is it located?
 - Where are tools and supplies located underground?
 - Are there storage areas for oil, oxygen, acetylene tanks, or explosives in the area to be explored?
3. What checks and duties should the team captain perform before the team travels to the Fresh Air Base, and before the team travels beyond the Fresh Air Base?

Answers:

- Check each team member's physical condition.
- Ensure that all apparatus are checked and operating properly.
- Ensure that all needed tools and equipment are ready and working properly.
- Ensure that all team members understand the instructions from the briefing session.

(Continued on next page)

- Check lifeline signals with Fresh Air Base Coordinator.
- Synchronize all watches.
- Obtain all necessary information from team coming out.
- Ensure that an up-to-date map is readied.
- Check apparatus of each team member after going under oxygen (proper functioning, good seal, ready to go).

Exploration Methods and Procedures

Every mine emergency is different, so each one presents its own problems. Although it's difficult to tell exactly what you'll be doing during any exploration, there are some accepted methods and procedures for carrying out basic exploration work.

These methods and procedures have developed over the years, as mine rescue teams have gained knowledge and experience from the many challenges that come with mine rescue and recovery work.

There are two primary methods of mine emergency exploration for which your team will need to practice and prepare:

1. "Rapid Exploration"
2. "Advance, Tie Across and Behind"

Rapid Exploration

NOTE: Rapid Exploration requires the use of radios and can be used **only** in areas **CLEAR OF SMOKE**. Also, if the team encounters an **IRRESPIRABLE ATMOSPHERE** while using this method, at least **TWO** team members will need to travel together in an entry, **EVEN IF THE AREA IS CLEAR OF SMOKE**.

This exploration method allows the mine rescue team to split up and explore multiple (adjacent) entries simultaneously, while maintaining in constant radio contact with their other team members, the Fresh Air Base, and the Command Center.

Using this method, it is common practice for the team members to travel one crosscut, then communicate information (via hand-held radio) to the Fresh Air Base **and** the Command Center simultaneously, if the system permits.

When permanent stoppings, equipment, or materials are found in crosscuts and causes a visual obstruction between two adjacent entries, **at least two** team members should travel together in these entries. These two team members will also need to maintain radio contact with the rest of the team.

When using this method to explore, **ALWAYS** maintain radio communication between the team members. If radio communication is interrupted for any reason, exploration **stops** until communication is reestablished.

NOTE: When a team encounters smoke, **they MUST return to the communication/lifeline system (lifeline)**.

Changing Conditions

The team may encounter changing conditions or circumstances that would require them to immediately reassemble and continue exploration using the “Advance, Tie Across and Behind” method. These changing conditions include:

- Smoke that limits visibility.
- Discovery of a fire.
- Discovery of a Refuge Alternative or Rescue Chamber.
- Discovery of a victim requiring assistance, including first aid and/or extrication.
- Team member experiences a “problem” such as apparatus malfunction or physical issues.
- Travel in an entry is blocked.

NOTE: If this happens, the affected team members will need to travel to an adjacent entry and advance in **that** entry, until they can gain access to their assigned entry. Once the team member regains access to their assigned entry, they must or should tie in behind them and resume explorations.

Guidelines for Rapid Exploration

If mine rescue teams are to be deployed using the Rapid Exploration method:

- A wireless communication system must be in place and operating.
- The communication system’s radio signal strength must be monitored.
- Radio communication must be maintained between ALL exploring team members, the Fresh Air Base, and the Command Center.
- All team members must be familiar with and have up-to-date training on the wireless communication system to be used.
- Must have a minimum of **two** persons per entry to be explored: one person operating radio and one person monitoring the gas detector.
- There must have “good” visibility in the areas to be explored.
- Teams must map relevant information in all entries explored.

Advance, Tie Across and Behind

This more commonly-used method of exploration has been a standard procedure for many years whenever mine rescue teams encounter smoke. Using this method, the team travels closely together on a sound-powered communication/lifeline system (cable and cable reel), referred to as the “lifeline.”

Advancing and Tying In

Using this method, you “tie in” as you advance. “Tying In” is the process by which you systematically explore all crosscuts and adjacent entries as you advance so that you are never in by an unexplored area.

As you advance within the affected area, it’s recommended that you use the least obstructed travelway and stay on intake air whenever possible.

Until you’ve explored each entry and crosscut, you have no way of knowing what the conditions are in these areas. For example, there may be a fire located in an adjacent entry which could spread and cut off your escape.

By tying in, you are ensuring that there is never any unexplored area between you and the Fresh Air Base. Even though you know (or think you know) where survivors are located, or where a fire or explosion has originated, it’s absolutely essential for you to tie in as you advance.

As your team advances underground, the captain always takes the lead, followed by the other team members. It’s standard practice for the team captain to enter unexplored areas ahead of the rest of the team to check roof and rib conditions.

In most cases, the co-captain will be the No. 5 person. In this position, the co-captain can easily keep an eye on the other team members to make sure they’re proceeding without difficulty. The co-captain can then quickly halt the team if anyone appears to be having trouble.

NOTE: The Command Center must **ALWAYS** consider, first and foremost, the safety of mine rescue teams and all other personnel involved in the operation. In mine rescue and recovery work, conditions could change very quickly. A hasty or misguided decision could mean **disaster and the loss of life**. During exploration, your team’s safety **MUST ALWAYS** be the first priority.

Standard Exploration Procedures and Practices

Team Checks

Regardless of the method the team uses to explore, one standard procedure you'll use during exploration is the "team check." There are three main reasons for the team check:

1. To make sure each team member is fit and ready to continue.
2. To make sure each team member's apparatus is functioning properly.
3. To give the team a chance to rest.

Usually, the captain conducts the team checks by simply halting the team briefly, asking each team member how he or she feels, and checking each team member's apparatus.

It's recommended that these team checks be conducted every 15 to 20 minutes. However, under certain conditions, the team may not be able (or may not find it feasible) to stop this often. It is also recommended that you make your first stop for a team check just in by the Fresh Air Base.

If a team member is feeling unfit to travel or an apparatus is malfunctioning, the journey back to the Fresh Air Base is relatively quick and easy at this point.

This first team-stop in by the Fresh Air Base also allows you to check that all components of the Communication and Tracking Systems are functioning properly.

For teams using a compressed oxygen breathing apparatus, the captain usually notes each team member's gauge reading at each rest stop, and reports the lowest reading to the Fresh Air Base and the Command Center. The lowest reading may then be used as a reference point to determine when the team should return to the Fresh Air Base.

In addition to checking each team member and their apparatus, team stops allow the team a chance to rest. If your team is searching for survivors, you'll probably want to advance rapidly, but rest stops are still important; be sure to allow time for them. How long you stop for each check will be determined by the conditions you encounter and the work you are doing.

Rest stops are also important (perhaps more so) on the return trip. The team will usually be more tired once they've completed their work. Don't forget to allow time for team checks as you travel back to the Fresh Air Base.

Rate of Travel

The speed or rate at which you will travel underground is usually determined by the team captain. Your pace may change continually as you explore, reflecting changes in surrounding conditions that occur as the team advances.

Your rate of travel will depend on a number of factors. Poor visibility, for example, will slow you down, as will an obstructed or inclined travelway. You also won't be able to move as quickly if the team is carrying something, such as heavy equipment or an injured person.

If the team is on their way back to the Fresh Air Base, or if they've been doing strenuous work, they will naturally be more tired. Again, the captain should adapt the rate of travel to take this into account.

Traveling in Smoke

Traveling in smoke always presents difficulties for a mine rescue team. The biggest problem is the fact that you can't see where you're going as easily.

The smoke may be light enough that it limits your visibility only slightly, like a light fog or mist. But smoke can also be so dense that it will completely obscure everything around you.

Smoke so dense that it conceals the roof, ribs, and other reference points you normally use to guide you from place to place can cause you to experience what's known as "spatial disorientation."

When spatial disorientation occurs, you lose your sense of "which end is up," so to speak. You may bump into things and perhaps even completely lose your balance and fall down.

For these reasons, it's recommended that when rescue teams travel in smoke, all team members should be linked together by means of a linkline.

The captain can use a walking stick as an aid in checking the area in front of the team for roof falls and other obstructions.

There are also two methods commonly used to help you see a little better when you're traveling in smoke. One method is to remove your cap lamp from your cap and hold it at waist level.

Because your cap lamp is normally above eye level, it can produce glare in smoke. If you've ever tried to travel through dense fog with your car's high beams on, you know how difficult it is to see. You can see much better in fog with the low beams on because they produce less glare.

Another way to improve your visibility in heavy smoke is to let the lamp hang from its cord to light up the rail or rib that you're moving along. This technique helps you see a little easier because the smoke is usually less dense closer to the mine floor.

If smoke is so dense as to make visibility very poor, you may need to keep in constant physical contact with a rail, a compressed air or water line, or the rib in order to “feel” your way along.

In certain circumstances and under acceptable conditions (**less than 1 % of methane in the area affected**), the use of a **Thermal Imaging Camera** can greatly enhance to the efficiency and effectiveness of rescue/recovery teams

NOTE: The Command Center should be informed when you consider using a Thermal Imaging Camera. **ALWAYS** follow the manufacturer’s instructions for use.

Traveling Through Ventilation Controls

As your team advances, you may find it necessary to determine conditions on the other side of doors, mandooors, or stoppings, or you may have to travel through them. This is normally done **only** on orders from the Command Center.

Before going through a ventilation control, the team should first try to determine what conditions exist on the other side of the door or stopping by feeling it for heat and looking for smoke.

Before you open and travel through any stopping inby which conditions are not **definitely** known, you should first erect a temporary stopping outby. Doing so provides an air lock which ensures that when the stopping is opened, you will not mix the atmospheres and alter the current status of the ventilation.

Traveling Through Water

When your team encounters water during exploration, the Command Center will usually decide how to deal with the problem. The captain can probe the water depth with a walking stick, if necessary.

If the water isn’t too deep and you can get through it without endangering the team, you will probably just travel through it.

NOTE: It’s recommended that you don’t travel through water that is more than knee deep (less in low coal). It may be a better option, if possible, to travel an alternate route and detour the water.

There is still one other alternative to be considered: If you have pumping equipment, and gas conditions in the area permit, your team may be able to pump the water out. The pump itself can be set up at the Fresh Air Base (or outby), with non-conducting suction lines leading to the water.

Hazards Associated with Pumping Water

When pumping water out of an affected area, the water itself may contain hazardous, water-soluble gases which can be released into the “good” atmosphere, outby the Fresh Air Base, as the pumping operation proceeds.

Also, any air that’s sucked into the line could carry hazardous gases. **NOTE:** Keep in mind that it’s **extremely important** to know the gas conditions at the site.

Crawling or Climbing

As you advance, it may be necessary to crawl or to climb inclines or ladders. Keep in mind that this tires the team, so you should do it only when absolutely necessary.

Marking Route of Travel

As the team advances, your lifeline trails along behind you, marking your route through the mine. Your captain or co-captain may also mark the team’s route with chalk or spray paint at key points.

Here’s how it’s done: As you proceed, the captain or co-captain marks an arrow along the rib at each intersection where your direction of travel changes. The head of this arrow points toward the Fresh Air Base.

As the team returns to the Fresh Air Base, the captain or co-captain draws an “X” through each arrow to show that the team has retreated.

There are two reasons for marking your route of travel: (1) It helps the team find its way back to the Fresh Air Base, and (2) if a backup team is sent in to look for you, it shows them which way you traveled.

Marking Areas Explored

As you advance, the captain also marks areas explored by initialing and marking the date on faces, entries, crosscuts, impassable falls, barricades, stoppings, and at other points where conditions don’t permit the team to advance.

All of these places should also be noted on your map. Marking areas as you explore provides a visual record of what your team did and found as they advanced.

Inspecting and Testing Roof and Rib

As you explore, the captain takes the lead, inspecting and testing the roof and rib before the team advances into the area.

Visual Inspections

Your team captain should constantly conduct visual inspections of the roof and ribs as you advance unless, of course, heavy smoke makes this impossible. Roof inspections should be made from rib to rib. At each face, the captain should inspect the face and ribs.

Roof and Rib Tests

Roof tests should be conducted when visual inspection indicates that the roof or rib may be unsafe or in areas where roof conditions are known to be bad, and at faces.

It may also be necessary to test in areas where smoke is so thick it doesn't permit visual inspection. Poor or unsafe conditions, such as falls of roof or ribs, also indicate the need to test.

In addition, the captain should make roof and rib tests when the team builds an air lock or stopping or erects a line curtain. Another time to test is before you extinguish a fire.

If conditions permit, roof tests should be made from rib to rib. Whenever possible, it's best to test all parts of an area that indicate the need for testing.

If you encounter bad roof, the team may need to timber it before you advance under it. If space permits, the team can simply detour the bad roof by walking to the right or left of it.

It's standard practice to mark this hazardous area with chalk or some other type of marker, and note the location on the mine map. This makes the hazardous area easy to spot, so you can detour it again when the team retreats.

When you retreat, you should leave the markers in place so that they will serve as a warning for other teams that may enter the area. **NOTE:** Some teams use other methods of marking the bad roof.

Testing for Gases

Monitoring the mine atmosphere for the presence of oxygen, methane, and carbon monoxide is another important element of team exploration.

Depending on the type of mine and the specific situation, you may have to test for other gases as well. **NOTE:** Be prepared to discuss any other gases for which the team may be required to test.

These tests should be made at each intersection you encounter, at the furthest point of travel into each crosscut, at each dead end, and at the face of each section you explore.

It's also necessary to conduct gas tests on the other side of doors or stoppings, or curtains prior to traveling through any of them, especially where conditions on the other side are not definitely known.

If you encounter smoke or potentially dangerous gas conditions, gas levels shall be frequently monitored as you advance.

NOTE: High-range, multi-gas detectors with a **specialized interface** can transmit gas readings in “**real time**,” directly and accurately to the Command Center and allows for continuous monitoring for gases in specific areas, without leaving mine rescue personnel behind to monitor and report gas readings.

Progress Reporting

During exploration, information the team relays to the Fresh Air Base and Command Center is known as the “progress report.” Progress reports keep Command Center and other personnel directing the operation up-to-date on what your team is doing, where you are, and what you've found.

Once the progress report is communicated to the Fresh Air Base and Command Center, This information may then be used as a basis for making further modifications to the rescue and recovery plan.

The progress report also helps keep track of your team so that if it becomes necessary to send a backup team in to find you, they'll know where to look. Include information such as the team's condition, the condition of each member's apparatus, the team's location, and their progress.

As you advance, report the condition of ventilation controls and auxiliary fans. If they are damaged, be specific as to what type of damage they've received and how extensive it is. Also, if doors or stoppings are blown out, be sure to report in what direction they have blown.

Report any other damage caused by fire, explosion, or other condition. If you encounter “coking” or coke streamers, report both their location and size. “Coking,” as mentioned here, refers to a grey-black residue that is sometimes left behind when coal is burned in the absence of oxygen. Its presence indicates that the area has been subjected to extremely high temperatures.

A progress report should also include information about roof and rib conditions, gas conditions, or an encounter with smoke or water.

You’ll need to report the location of tools, materials, and other equipment encountered as you progress. When you encounter any tools or equipment, you will need to report whether the power switch is on or off.

Report the condition of compressed air and water line valves (open or closed) and be sure to include the location of explosive magazines, storage areas for oil, oxygen, and acetylene cylinders.

Also, report the location and examine the contents of any dinner buckets you find, because these may offer important clues as to the whereabouts of survivors.

NOTE: Miners are taught that, if they become trapped in the mine, they should leave notes in their dinner buckets telling where they are. For this reason, the mine rescue team should search all dinner buckets they find during exploration.

If you locate survivors or bodies, report this immediately to the Fresh Air Base and the Command Center. In your progress report, be sure to include any other significant conditions, materials, or evidence the team encounters during exploration. When you report anything to the Fresh Air Base, be sure you clearly and correctly identify the location.

Mapping

As the team advances, the map person records what the team encounters by marking the information on a mine map. At the same time, the Fresh Air Base Coordinator marks a mine map with your findings based on what you include in your progress report. The same information is relayed to the Command Center, where a third map is marked with the team’s findings.

This “simultaneous mapping” provides the Fresh Air Base and the Command Center with a visual record of what is happening underground. Accurate, up-to-date mine maps are critical to a mine rescue operation.

Officials in charge on the surface use these maps as a basis for making decisions and providing the team with instructions.

NOTE: Refer to **Visual 5** as you explain what information should be marked on the map. Point out each marking as you discuss it.

Here is the type information you should mark on the mine map as the team explores:

1. Bad roof
2. Water
3. Smoke
4. Gas readings
5. Valves on water and compressed air lines (open or closed)
6. Firefighting equipment
7. Other equipment and tools
8. Types and position of power equipment (on or off)
9. Storage areas for materials
10. Evidence of fire and/or explosion
11. Dinner buckets
12. Condition of ventilation controls
13. Survivors
14. Bodies
15. Any other significant conditions, materials, etc.

Before you actually explore a mine, take time to establish a uniform set of map symbols and learn to use them. Familiarize yourself with the scale of the map you will be using. Before you go underground, make sure you have an adequate mapboard to place under the map.

The map person and the Fresh Air Base Coordinator should also practice together to develop their method of simultaneous mapping.

NOTE: ALL mine rescue teams should be trained on computer-assisted, electronic mapping systems like those used by MSHA's Mine Emergency Operations (MEO) Division of MSHA Technical Support. This system incorporates software that includes "click and drag" mapping symbols. Computer-assisted mapping is also included in the National Mine Rescue Contest Rules. **Refer to Visuals 6 and 7.**

Communication

During mine emergency rescue and recovery operations, effective communication is vital. It is extremely important that teams develop effective skills and methods of communicating among themselves, other teams, the Fresh Air Base, and the Command Center.

The backup team members should be included in **all** communications and briefing(s) for the active team(s); this keeps the backup team informed and fully aware of everything that is found and reported by the active team members.

Communication Systems

Discuss and/or demonstrate the **Underground Communication and Tracking System** used by MSHA's Mine Emergency Operations (MEO). Provide and facilitate hands-on set-up and use of the equipment, when available.

A secure and reliable communication system, utilizing a sound powered communication/lifeline cable and/or radios, must be established and maintained between the mine rescue teams, Fresh Air Base, and the Command Center.

NOTE: For radio communications, agree (in advance) on which team members will check and monitor radio signal strength and connection to the Fresh Air Base during the rescue operation. You'll need to:

- **Ensure that clear radio communication is maintained at all times.**
- **Determine, in advance, at what intervals and/or locations that signal strength will be checked.**

When using radios during exploration, use standard radio terminology and protocol for transmitting and receiving messages. For example, when you call out information:

- **Identify yourself and the receiver.**
- **Always confirm messages received.**

Communication with the Fresh Air Base and Command Center

As the team advances, it's essential to stay in close contact with the Fresh Air Base and the Command Center to report your team's progress and to receive further instructions.

At a minimum, teams generally use either sound or battery-powered communication equipment. One team member, usually the No. 5 person, wears the equipment, and is responsible for sending information to the Fresh Air Base and relaying instructions from the Fresh Air Base to the team.

Using the Lifeline Cable to Communicate (Signaling)

In the event that your team's communication system fails, you can still communicate some with the Fresh Air Base by tugging or pulling on the communication/lifeline system cable. The system's cable must meet requirements set forth in **30 CFR Section 49.16**.

At the Fresh Air Base, there should be an attendant who is in charge of unwinding your communication line as you travel. This person, usually known as a lifeline attendant, also monitors the line to make sure it's not getting snagged or caught.

NOTE: Teams are usually instructed to return to the Fresh Air Base **immediately if their communication system fails**. On the return trip, or if the team is unable to return immediately, they may still need to make use of lifeline signals.

If the team loses voice contact with the Fresh Air Base, it will be the attendant's job to receive and send signals to and from the team by means of the lifeline. **NOTE:** Refer to **Visual 8** as you discuss the signals.

The signals you use for communicating with the lifeline are the same as those you use with the signaling device:

One pull or tug:	Stop
Two:	Advance
Three:	Retreat
Four:	Emergency or Distress

If the team is stopped at one location for an extended period, or if it is performing a specific task, such as building a stopping or clearing a roadway, it is common practice for the Fresh Air Base to signal one long pull about every five minutes to check on the team's condition. The team should then acknowledge that they are okay by returning the signal.

When you're using the lifeline to communicate with the Fresh Air Base, the captain's signals to the team should also be relayed back to the Fresh Air Base.

The No. 5 person relays the captain's signals to the Fresh Air Base by repeating them on the lifeline and then waits for the Fresh Air Base to acknowledge that it has received the signal before sounding a response to the captain's signal. All this is done before the team executes the instructions dictated by the signal.

Actually, this is a lot less complicated than it sounds. Here's how it works: Say the captain wants to halt the team. He or she signals to stop the team.

For the benefit of the Fresh Air Base, the No. 5 person repeats the captain's signal by tugging once on the lifeline.

The attendant at the Fresh Air Base then acknowledges receiving the signal by sending it back to the team.

Once the No. 5 person receives the Fresh Air Base's acknowledgment, he or she then returns the signal to the captain. This means that (1) the No. 5 person has heard the captain's signal; (2) the signal has been relayed to the Fresh Air Base; and (3) is acknowledged by a return signal. The team may then proceed to execute the command dictated by the signal.

Problems with the Use of the Lifeline

Using the lifeline as a signaling device can present problems. For example, it becomes more difficult to signal with the lifeline if the team has advanced any great distance from the Fresh Air Base.

When your team travels up headings, crosscuts, and entries, the lifeline drags along behind you and has a tendency to get caught as it travels around corners. Debris and other obstructions you may encounter after an explosion or fire may also snag the line and limit its use.

Review questions: Ask the team members the following questions and allow time for them to answer.

1. What team signals do you use during exploration?

Answer: One—stop, two—advance, three—retreat, four—emergency

2. List four factors that affect a team's rate of travel.

Answer: Falls and obstructions, water, smoke, fatigue, amount/weight of equipment carried, degree of slope

3. Describe how a team marks its route of travel on advance and retreat.

Answer: As you advance, the captain or co-captain draws or paints an arrow along the rib at all intersections where your direction of travel changes. (The head of the arrow points toward the Fresh Air Base.) On retreat, the captain or co-captain puts an "X" through each arrow.

4. List some findings that should be marked on a mine map.

Answer: Dinner buckets, bad roof, water, smoke, storage areas, gas readings, valves on air and water lines, firefighting equipment, equipment and tools, power machinery, condition of ventilation controls, survivors, bodies, other significant conditions and materials.

Returning to the Fresh Air Base

It's very important for the team to pace its work so that it can return to the Fresh Air Base on time. Also, you must be sure to allow an ample supply of oxygen for the return trip to the Fresh Air Base plus an extra "margin of safety" in case anything unforeseen occurs.

Be sure to take into account the fact that you'll be more tired when returning to the Fresh Air Base, so the return trip will usually take longer than the advance. You'll probably need to take longer and more frequent rest stops on the return trip. If you're carrying a survivor, this will tend to make the trip even slower.

The time a team spends underground is usually limited to two hours or less. The exact amount of time is determined both by the underground conditions and the type of apparatus being used. The distance you can advance also depends on underground conditions. However, it is often recommended that you limit your advance to 1,000 feet.

NOTE: If your **state sets a limit** for advance during exploration, be sure to mention the **regulation that applies** to that at this time.

If your team is late getting back to the Fresh Air Base and has stopped communicating, a backup team will be sent in to look for you, even if it means delaying the entire operation. So, if you're going to be late, be sure to communicate your intentions to the Fresh Air Base and Command Center.

Under certain circumstances, even when you are working well within the time limits originally set, your captain may order the team to return immediately to the Fresh Air Base, if, for example, a team member's apparatus malfunctions.

You may also be ordered to return immediately if you encounter gas conditions that present an imminent explosion hazard, a fire that you can't extinguish, or excessive water. Your captain may also order you to return to the Fresh Air Base if you encounter bad roof that's impossible to detour and too hazardous to secure.

There are certain other conditions that won't necessarily require retreat but will hinder your team's progress. For example, encountering water in passageways will slow you. Dense smoke is also a hindrance. Climbing a steep incline or ladder or crawling for a distance will slow you also.

The team may be permitted to advance under these conditions if it's definitely known that a life will be saved by the action, and **if you have the approval of the officials in charge of the operation.**

Debriefing

When you return to the Fresh Air Base, your team captain will confer with the Fresh Air Base Coordinator and the captain of the incoming team to exchange information about what the team saw and found.

At this time, the team captain and the Coordinator should compare maps to make sure their markings correspond.

The information that your team captain should transfer to the backup team includes such things as the traveling conditions your team encountered, how far you traveled, what gases you encountered, and roof and rib conditions.

If your team built stoppings, your captain should explain what you constructed and what remains to be completed. Be specific about any equipment and supplies your team left in the area. Your team captain may also make suggestions as to what equipment the incoming team should take with them.

When you arrive on the surface, your team will attend a debriefing session. Like the briefing session, the debriefing session is set aside for information gathering. This time, however, your team **provides** the information. You inform the debriefing official or committee of what you did, saw, and found during exploration.

Besides reviewing your team's findings you'll also review the team's map to make sure the markings on it correspond with the master map. During the debriefing session, you are also generally told what you should and should not say to media representatives and to others.

The debriefing session is a very important aspect of your team's exploration. Often, significant details that appeared to be unimportant while you were underground or were simply overlooked in your progress reports come out during this debriefing session and turn out to be important factors to the operation.

The following is important information that the Command Center should receive from the mine rescue team:

- Percentage of assignment completed.
- Location on map of their stopping point.
- Location and Identity of any persons encountered and left in the mine.
- All potential ignition sources encountered by the team such as fires, batteries or other sources.
- Condition of ventilation system, including the condition of ventilation controls.
- Any condition that hindered or stopped team travel.
- Any specific notable conditions or problems while exploring.
- Any problems with your equipment.
- Additional supplies needed at the Fresh Air Base.

Review questions: Discuss the answers with the team so they fully understand the material covered in this section.

1. Under what conditions/situations might your team captain order your team to return to fresh air immediately?

Answer: Malfunctioning apparatus, hazardous roof that cannot be secured, presence of gases that produce an imminent explosion hazard, fire that cannot be extinguished, excessive water.

2. What information is usually transferred from the outgoing team to the backup team at the Fresh Air Base?

Answer: Markings on mine maps, damages, distance traveled, gas conditions, roof and rib conditions, stoppings constructed, equipment or supplies left in the area, and any other important information.

3. Why is the debriefing session important?

Answer: It provides the surface officials with more detailed information, ensures all important findings are mentioned, provides time to check team's map against master map, and instructs team as to what they should or should not say to media representatives and others.

Improvements in Mine Rescue Technologies

Wireless Communications and Tracking Systems

NOTE: Refer to **Visual 9**.

Mine rescue communications and tracking systems which have been developed in recent years can now be deployed to allow for direct, real-time communication between **all** team members and the Command Center.

These systems enable direct and simultaneous communication between the advancing mine rescue teams, Command Center, Fresh Air Base, and backup mine rescue teams.

The Command Center now has the capability to continuously monitor (in real time) the progress of the advancing team, along with gas readings from sensors and detectors left in specific areas by mine rescue teams and personnel. As the team advances, or if they are forced to retreat, the sensors will continue to transmit data back to the Command Center.

Computer-Assisted Mapping

MSHA's Mine Emergency Operations (MEO) uses computer-assisted mapping systems that feature easy-to-use "click and drag" symbols. Computer-assisted mapping is also included in the National Mine Rescue Contest Rules.

One type of click-and-drag mapping software commonly used in mine rescue training is called Microsoft® Visio®. This software is also used in mine rescue contests.

For an actual mine emergency MSHA MEO would use *AutoCAD*® software for mapping which also features click-and-drag symbols very similar to the symbols used by Microsoft® Visio®.

Team members should receive training on all communications and tracking equipment they may use during a mine rescue operation.

TRAINING TIP: If you are training with multiple teams, you could create a scenario to help team members better understand decision-making process of the Command Center. For example:

- Assign *Team A* to explore, while members of *Team B* coordinate and direct exploration activities from the Fresh Air Base and/or Command Center.
- When team A completes their assignment, they return to the Fresh Air Base and/or the Command Center, where Team B will conduct a debriefing session.
- Then, have them to switch responsibilities so that *Team B* can explore, while *Team A* directs them from the Fresh Air Base and/or Command Center.

NOTE: Refer to *IG 7a – Advanced Skills Training Activities for Coal Mine Rescue* for other practical exercises related to exploration.

REQUIREMENTS FOR A FRESH AIR BASE

1. Positive ventilation and fresh air
2. Travelway for people and supplies
3. Communication with Command Center
4. Communication with team

Visual 1

Requirements for a Fresh Air Base

COORDINATOR'S RESPONSIBILITIES

- 1. Communication with team and Command Center**
- 2. Follow and mark team's progress on map**
- 3. Coordinate and oversee all activities**

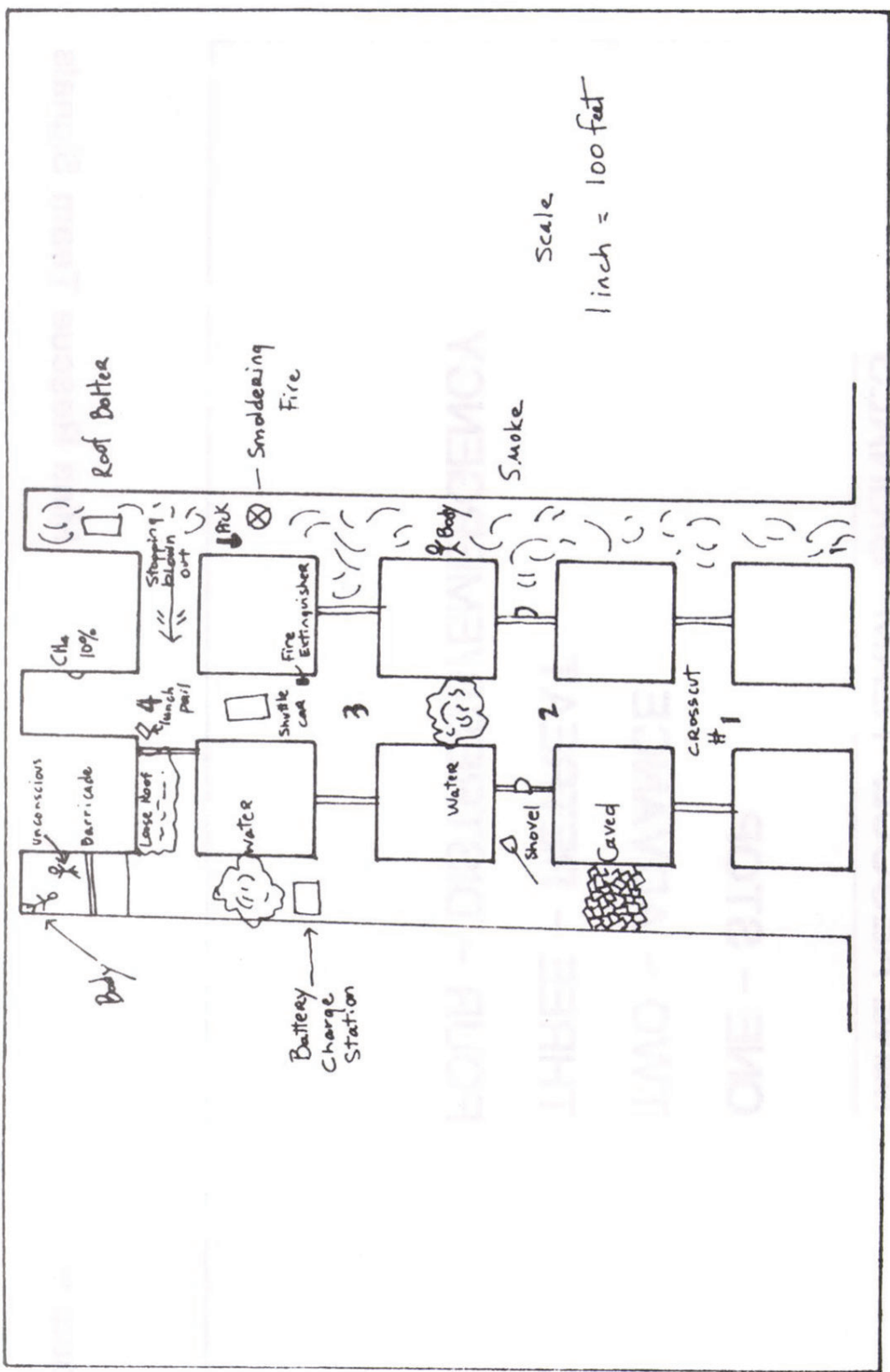
Visual 2

Fresh Air Base Coordinator's Responsibilities

Briefing Questions

1. Is the evacuation complete? Are any miners missing? If so, how many and what are their possible locations?
2. What is known about the cause of the disaster?
3. Is your team the first one to explore? (In multi-level mines, the team would also want to know if there are any other teams working on other levels.)
4. Have state and Federal officials been notified?
5. Are guards stationed at all mine entrances?
6. Is the ventilation system operating? Is it an intake or exhaust system? Are attendants posted at the surface ventilation controls? Have air samples been taken? If so, what are the results?
7. Will there be a backup team standing by at the Fresh Air Base, and reserve teams on the surface?
8. What are the team's objectives, and what is their time limit?
9. What conditions are known to exist underground?
10. Is the mine's communication system operating? Is it being monitored?
11. Is power to the affected area on or off?
12. Is there diesel or battery-powered equipment or a charging station in the affected area?
13. What type of equipment is in the area? Where is it located?
14. Where are air and/or water lines located? Are they in operation? Are valves known to be open or closed?
15. What type of firefighting equipment is located underground? Where is it?
16. What tools and supplies are available underground? Where are they?
17. Are there storage areas for oil or oxygen, acetylene tanks, or explosives in the area to be explored?

Visual 4

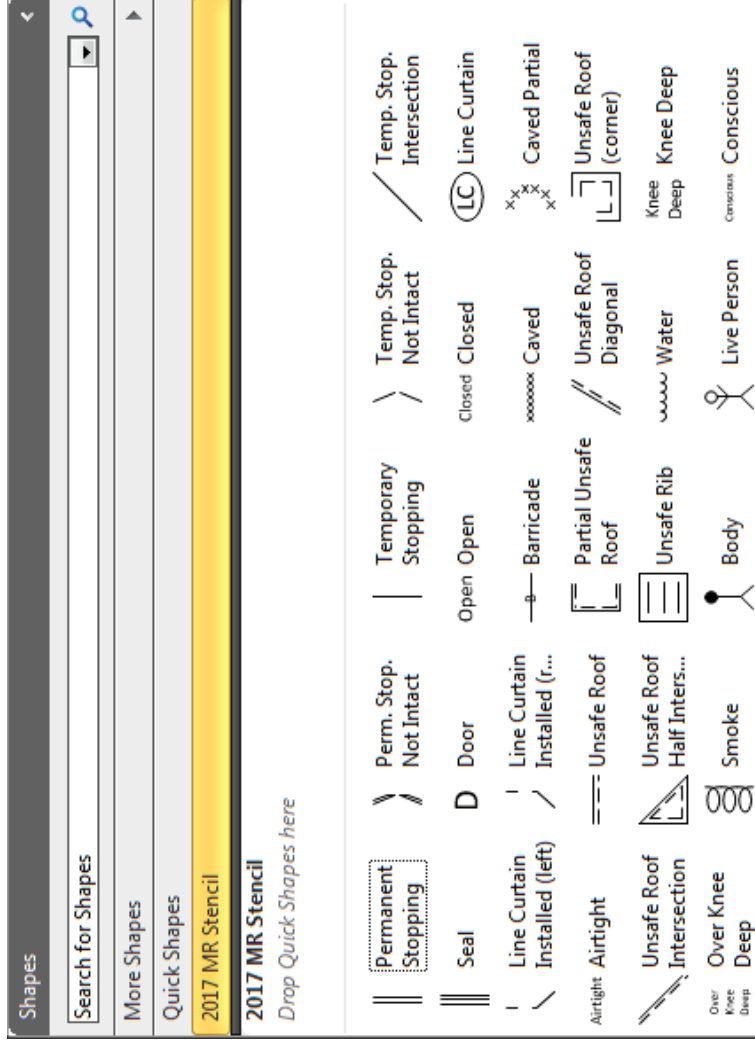


Visual 5

Marking the Mine Map

Microsoft® Visio® Mapping Software

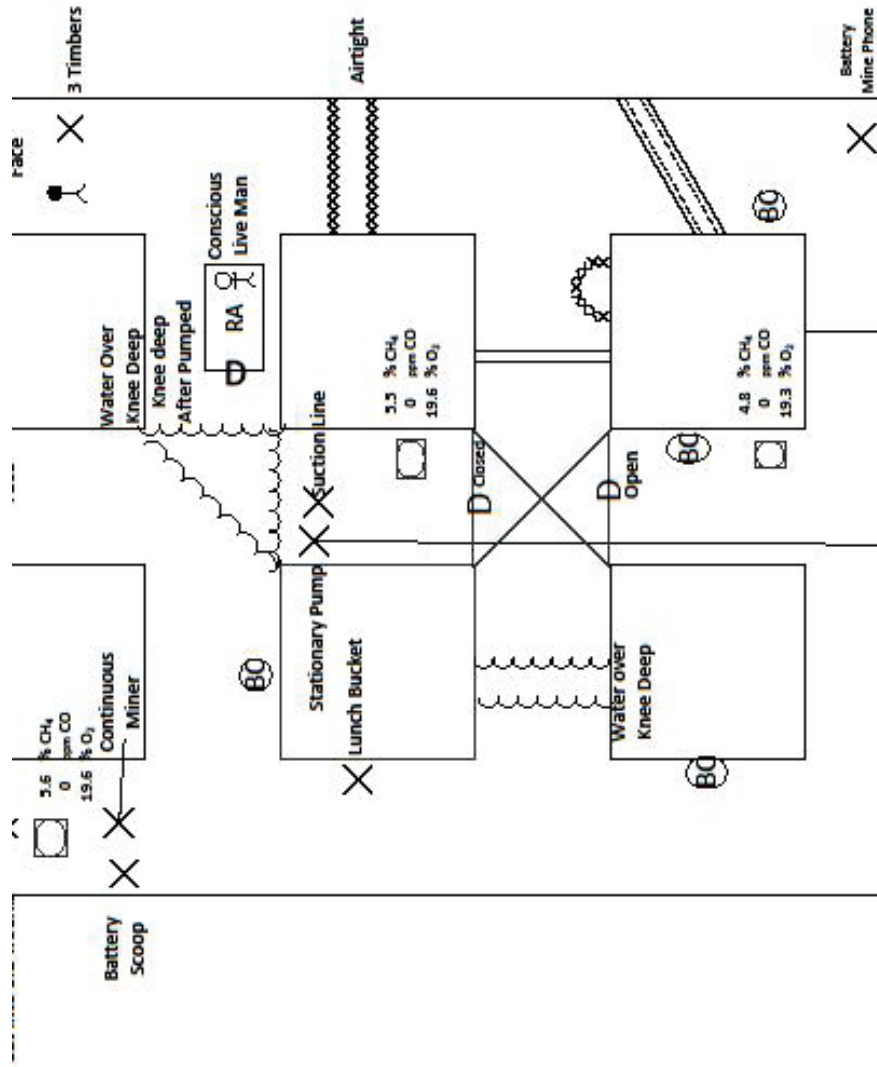
For an actual mine emergency MSHA MEO would use AutoCAD® mapping software which also features “click and drag” symbols very similar to the symbols used by Visio®



Visual 6

Click/Drag Mapping Symbols

Sample Map Using Mapping Software Symbols



Visual 7

MINE RESCUE TEAM SIGNALS

ONE-STOP

TWO-ADVANCE

THREE-RETREAT

FOUR-DISTRESS/EMERGENCY

Visual 8

Mine Rescue Team Signals

IWT® Communications System Set-up

ALWAYS follow manufacture's recommendations for care, maintenance, and use of any mine rescue communications system.

Equipment needed (pictured below):

- Gateway
- Yagi Antenna or Disc Antenna
- Fiber Switch
- Smart Battery
- Cable Set
- Fiber connection from a fiber reel
- IWT Radios (Minimum of 2)
- Portable MESH Node (PMN)



PMN



Gateway



Smart Battery



Fiber Switch



Disc
Antenna



Cables Set



IWT
Radios



Fiber Reel



Yagi Antenna

Visual 9

General Review

Exploration

Choose the correct answer to each of the following questions.

1. Prior to rescue team exploration, the first step to take after a disaster is to:
 - a. Examine all mine openings.
 - b. Establish a Fresh Air Base.
 - c. Proceed as far as possible into the mine without apparatus.
 - d. None of the above.

2. The purpose of rescue team exploration is to:
 - a. Determine conditions underground.
 - b. Locate missing miners.
 - c. Locate clues or indications of missing miners' locations.
 - d. All of the above.

3. If at all possible, entry into the mine should be made on:
 - a. A return airway.
 - b. An intake airway.
 - c. The main haulageway.
 - d. The belt entry.

4. Barefaced exploration should be attempted only when:
 - a. No breathing apparatus is available.
 - b. Miners are trapped in the mine.
 - c. A backup mine rescue team with apparatus is immediately available.
 - d. A Fresh Air Base is established.

5. In advancing a Fresh Air Base, after you put up the new air lock, the team should:
 - a. Come out of the mine.
 - b. Perform gas tests in all dead ends and high places between the old and new Fresh Air Base to ensure that all gases have been flushed from the area.
 - c. Proceed in by the new Fresh Air Base to explore and let other workers check for any gases out by the new Fresh Air Base.
 - d. Shut off and remove your apparatus since you are in fresh air and will no longer need it.

6. When exploring in heavy smoke, it is recommended that the team:
 - a. Use a linkline to hook all team members together.
 - b. Follow along the rail to aid their progress.
 - c. Keep in contact with the side to aid their progress.
 - d. All of the above.

7. Prior to a mine rescue team passing through a door or stopping behind which conditions are not definitely known, they should:
 - a. Ask the Fresh Air Base to send in the backup team.
 - b. Erect an air lock to prevent the mixing of atmospheres.
 - c. Open the door or stopping and wait at least 10 minutes so that any harmful gases are diffused.
 - d. Never enter such areas.

8. Gas readings should be taken:
 - a. At all intersections.
 - b. At any dead end or face area.
 - c. At the furthest point of travel in any entry or heading.
 - d. All of the above.

9. The captain should mark the date and his or her initials:
 - a. Each time the team stops for a rest.
 - b. Every 50 feet.
 - c. Every 200 feet.
 - d. On all explored areas (faces, entries, crosscuts, impassable falls, barricades, stoppings, etc.)

10. Dinner buckets encountered during exploration are important because:
 - a. They can contain food and/or water for the rescue team.
 - b. They may contain notes that would indicate the whereabouts of survivors.
 - c. They indicate where miners ate their dinner.
 - d. None of the above.

11. If a team member experiences problems with his or her apparatus in by the Fresh Air Base, the team member should:
 - a. Be immediately sent back to the Fresh Air Base.
 - b. Be sent back to the Fresh Air Base with another team member.
 - c. Switch to the apparatus that was carried on the stretcher or stokes basket.
 - d. With the entire team, return immediately to the Fresh Air Base.

12. Debriefings are held to:
 - a. Inform news reporters of developments.
 - b. Inform family members of developments.
 - c. Review the rescue team's findings after they have returned from underground.
 - d. All of the above.

General review answers:

1. a
2. d
3. b
4. c
5. b
6. d
7. b
8. d
9. d
10. b
11. d
12. c

Glossary

Air lock – An area in the mine closed at both ends by doors, or by stoppings with flaps or doors in them. Used to prevent mixing of different atmospheres while still permitting miners to enter and exit.

Backup team – Rescue team stationed at the Fresh Air Base as a “backup” for the working team inby the Fresh Air Base.

Briefing – Session held before a team goes underground to inform team members of conditions underground and give them their work assignment.

Debriefing – Session held when a team returns to the surface after completing an assignment to review what they saw and did.

Fresh Air Base – Base of operations from which the rescue and recovery teams can advance into irrespirable atmospheres.

Lifeline – Rope line or cable from communications system that links the team to the Fresh Air Base. It may be used as a manual communications system to the Fresh Air Base [30 CFR 49.16(a)(8)].

Linkline – Line that links team members together. Used in smoke, it is usually a rope about five feet long with rings for each team member to hook onto.

Progress reporting – Information the team relays to the Fresh Air Base as it proceeds.

Standby team – Team scheduled to be on the surface in ready reserve when rescue teams are working underground.

Tying in – Systematic exploration of all crosscuts and adjacent entries so that the team is never inby an unexplored area.